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THE ASSESSMENT OF NASA TECHNICAL INFORMATION

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THE ASSESSMENT OF NASA TECHNICAL INFORMATION

EXECUTIVE SUMMARY

It is a well-established fact that human organizations in both government and private enterprise can function well only when they receive systematic feedback about their performance. Without that information, executives have little upon which to base their decisions for managing and improving the quality of their products.

The National Aeronautics and Space Administration (NASA) and the aeronautical industry are, in a very real sense, partners in the aerospace venture in the United States. The primary product produced by NASA, scientific and technical information, is the foundation for many of the advances in the aeronautical industry and one of the primary reasons for the continued United States superiority in the global aircraft market.

To date, however, NASA has obtained very little systematic feedback from the aeronautical industry regarding the quality of the scientific and technical information it produces. Specifically, little is known about the industry's perspectives on (1) its information needs, (2) benefits of receiving NASA technical information, (3) the inadequacies in NASA technical information, and (4) changes in the content, presentation, and dissemination that would improve the information.

The primary purpose of this report is to provide NASA with feedback from the aeronautical industry that can be used by NASA directors in managing and improving the quality of its scientific and technical information. The secondary purpose is to develop a feedback and monitoring system which can provide NASA with periodic and systematic information from users of its technical information in the aeronautical industry. Although NASA does research in a large number of areas, the aeronautical industry was chosen for this study because aeronautics has been a longstanding focus for NASA efforts and the companies in the industry are well-defined recipients and users of NASA technical information. The field also provides a representative subset of all NASA work and, because of the length of time NASA has worked in the field, a study of aeronautical companies made comparisons between NASA and NACA feasible.

This Executive Summary of the study entitled "The Assessment of NASA Technical Information," highlights information contained in the final report to NASA. The numbers in parentheses following each section indicate the page number of the final report where further information may be located.

Design and Methodology of the Study

The study had two major objectives:

1. To identify how NASA technical information is disseminated and utilized within aerospace companies; and

2. To analyze the perceived quality and usefulness of NASA technical information by the users in the aeronautical industry.

To identify how NASA technical information is disseminated and utilized within aeronautical companies, it was necessary to: (1) determine how information is received, stored, and distributed, (2) identify direct and indirect users of information, along with differences in usage patterns, (3) identify user characteristics affecting the use of technical information within companies, job classifications, and other situations, and (4) identify types of information needs (content) and needed or desired methods of presentation (format).

To analyze the perceived quality and usefulness of NASA technical information by users in aeronautical companies, it was necessary to: (1) obtain evaluations of the quality and usefulness of NASA and other technical information by direct users, (2) identify ways in which NASA technical information aids the work of individuals within aerospace companies, (3) compare the use of NASA technical information to other similar sources, and (4) identify the major dimensions or criteria by which users make their evaluations.

The study included all private corporations which were subscribers to automatic distribution of NASA aeronautical publications in September 1978. Of the 45 companies identified, 40 agreed to participate in the study; the five which declined tended to be smaller companies with relatively limited use of NASA technical publications.

Three groups of direct or indirect users were identified: (1) executives (department managers, division heads, chief engineers, or others managing engineering or research and development groups), (2) researchers (engineers, designers, scientists, and technologists), and (3) librarians.

A series of questionnaires was designed and mailed to members of each group between mid-January and mid-February of 1979. These questionnaires attempted to determine specific usage and general evalution data. In addition, the most direct users of NASA technical information, researchers, were given abstracts of all NASA-produced aeronautical publications announced in NASA's Scientific and Technical Aerospace Reports (STAR) from January through October of 1978. Forms were included to obtain more specific evalution data on a random sample of actual publications. A total of 450 executives, researchers, and librarians participated in these parts of the study and 70% of all questionnaires mailed were returned.

Following collection of these data, personal interview were held with executives and senior managers in six companies throughout the United States.

The in-depth interviews provided additional information on questions raised by the mail survey responses, as well as senior-level insights on broader company information needs and relationships with NASA.

An additional research instrument was developed using a multidimensional scaling technique (MDS). MDS is used in human communication research to determine the relationship between two or more concepts, measuring the psychological distance the concepts are located from each other. If, for example, the concept of a technologist's job is close to the concept of technical information, it suggests that technical information is an important part of the person's job. If the two concepts are relatively far apart, it suggests that technical information is not too relevant to the every day work of the individual. MDS is useful in providing a direction for message strategies aimed at changing the relationship of concepts to each other. The instrument was administered in person to groups of scientists and technologists in the six companies visted for the executive interviews. There were a total of 101 completed MDS questionnaires.

The 40 companies which participated in the mail questionnaire part of the study ranged from as few as 35 employees in one company to more than 100,000 employees in several companies, with the average number of employees about 32,000. Among all executives, researchers, and librarians, the average age was middle to late forties, the average length in the company was 15 years or longer, and 92% had earned a bachelor's degree (about 45% had one or more MA degrees and about 25% possess a PhD degree). Average age and years with the company of executives was slightly greater than those of researchers. (II-32)

Major Findings

The following is a summary of the major findings. These are organized into three major sections: (1) assessments of NASA technical information, (2) major issues, and (3) the image of NASA technical information.

Assessments of NASA Technical Information

Sources of All Technical Information. Technical journals, particularly AIAA journals, were listed as the most frequent sources of technical information by both executives and researchers. NASA publications were the second most important sources of technical information, followed by publications of a variety of other associations, government agencies and military branches, and other organizations. (35-36)

Sources for NASA Technical Information. The two primary sources for obtaining NASA documents are NTIS (84%) and STIF (70%). DDC (52%) and NASA Research Centers (50%) were also mentioned by at least half of the librarians as sources for NASA publications. Librarians also reported that when individual copies of NASA publications are ordered, approximately 42% are ordered through DDC and 39% from NTIS. (36-38)

Sources for Learning About NASA Publications. Thirty percent of industry users of NASA publications learn about them through newsletters, often produced internally by librarians. About 21% become aware of NASA publications through STAR and 15% learn about them through NASA contracts. Other sources for learning about NASA publications include journals, colleagues inside the company, SCAN, and colleagues outside the company. (39-40)

Frequency of Use of NASA Publications. Executives report using NASA documents on an average of 27 times per year, or once every two weeks. Researchers use NASA publications more frequently, averaging about once every seven days. Personal interviews indicated that frequency of use largely depends upon the nature of projects and the relevance of NASA publications. (40-42)

Ordering NASA Publications. Nearly half (48%) of the executives and (43%) of the researchers reported they had not ordered individual copies of any documents over the past year. While all of the companies in the study were on automatic distribution, librarians reported that the primary reason (55%) for ordering an individual copy was that it was referenced in STAR but was not on automatic distribution; about 20% of the time a document was supposed to be in the automatic distribution package but was never received. When individual copies are ordered, the largest numbers are in the categories of Aeronautics (77%), Engineering (73%), and Math and Computer Science (71%). (42-46)

Effort to Obtain NASA Documents Within Companies. Researchers (73%) reported very little effort in obtaining NASA documents within their companies, suggesting that companies themselves are not a major source of problem for the distribution of NASA documents. Most executives, in fact, reported that from 75% to 90% of the time their libraries either have information available within the company or are able to obtain it in a reasonable amount of time. (47-49)

Timeliness of NASA Technical Information. Only a small percent of the executives (8%) and researchers (11%) report that they receive NASA information after it is too late to use; 65% of executives and 58% of researchers report they receive NASA publications during the middle of a project; and 26% of executives and 30% of the researchers receive the information they need at the planning stages or beginning of a project. These findings suggest that NASA is doing a reasonably good job in getting the information it produces to the companies before it is too late to be of use. (49-53)

Evaluation of Specific NASA Aeronautical Publications. Researchers first became aware of the documents they evaluated through communication within their own organization (30%), followed by STAR Abstracts (21%) and face-to-face communication with NASA personnel (11%). Nearly half of the researchers (47%) had read all of the article they evaluated and 80% reported having read half of the document. Clearly the researchers saw the most important aspect of the articles they evaluated as maintaining their professional awareness (71% said the articles were important or very important for this function). Equally as clearly, the respondents indicated that the articles were unimportant for saving their company money and for saving person hours on the work project.

On two dimensions, respondents indicated somewhat greater importance than unimportance: providing new ideas and validating their own research. Four other dimensions were indicated to be somewhat less important than unimportant: preventing duplication of work, improving the quality of work, helping to apply their own ideas, and suggesting alternative methods. (54-60)

Industry Communication with NASA Personnel. In addition to reading publications, various forms of direct, personal communication with NASA personnel are an important, and in some cases, the primary source of new information. Executives tend to have more direct, face-to-face communication with NASA personnel (16 times a year) than do researchers (eight times a year). The number of telephone conversations with NASA are about the same for executives

(22 times a year) and researchers (19 times a year), as are written communications (executives 10 times a year and researchers seven times a year). (60-65)

Executives report that direct, face-to-face communication is very important (42%) and twice as important as written correspondence (21%). The same results also hold, though not quite so strongly, for the researchers. A third of the executives (35%) indicated the telephone was a very important means of communication with NASA personnel, while 40% of the researchers indicated that it was very important. Executives consider face-to-face communication more important than telephone communication, but researchers see it as about the same in importance. (60-65)

Executive Comparison of NASA and NACA. Sixty-three percent of the executives in the study reported direct, personal experience with NACA. Overall, executives view NASA more favorably than they do NACA in terms of ease of applying information, validating findings, providing alternate methods, reducing costs, and superiority of information. However, there is a fairly large percentage who view NACA as superior in some aspects. Two areas where NACA is judged superior are NACA's (1) orientation toward more basic research which provided more definitive statements and comprehensive data and (2) narrower focus on aeronautical problems which led to high quality, in-depth research on basic topics. (65-70)

Major Issues

Needs, Benefits, Inadequacies, and Changes. Technical information on specific topics (i.e., materials, aerodynamics, aircraft and flight control, etc.) is the major information need of executives (54%) and researchers (64%). Also of importance are a number of general content topics and the manner in which information is presented. The specific content of NASA technical publications is cited by executives (57%) and researchers (69%) as the major benefit of receiving NASA technical publications, although executives more than researchers also cite assistance with planning and problem-solving and assistance in working with NASA as relatively important benefits. Executives and researchers are in nearly complete agreement that the two major inadequacies of NASA publications are the ways in which information is presented and the dissemination methods. Content generally is not seen as a major inadequacy. Among the changes recommended, changes in dissemination methods rank slightly higher than methods of presenting information. (79-86)

Content. The major inadequacy of content, according to executives (48%) and researchers (46%) is the lack of state-of-the-art publications published by NASA, and the lack of relating current research information to that of past or other on-going projects. Twenty-four percent of the executives and 13% of the researchers cite the lack of basic research as a major inadequacy. Among specific changes recommended, executives (33%) and researchers (22%) would like greater information on configurations, while 22% of both executives and researchers would like to see more state-of-the-art publications, along with better relating of one project to others. Generally, researchers feel NASA publications help with problem-solving more than do executives, while executives see more benefits than do researchers in the assistance NASA publications provide in working more effectively with NASA. (86-95)

Presentation of Information. Executives (28%) more than researchers (17%) rank insufficiency of data as the major inadequacy of NASA publications. Other inadequacies (all under 20% each) include: lack of relevancy to current needs, lack of applicability, narrowness, too generalized, and lack of adequate analysis. Both executives and researchers would like to see NASA technical information more relevant or applicable to their work, along with better analyses of results, test verifications, and correlations and other parametric data. (95-99)

Writing Style. Generally, writing style is not a major problem, although executives would prefer a less formal, tutorial style, and researchers believe that sections on design considerations, for example, should be written for designers, cost sections for cost analysts, etc. (99-100)

Format and Design. Both executives (43%) and researchers (50%) prefer traditional print publications over microfiche. There are, in fact, several problems with microfiche identified by both groups, including quality and convenience. Another problem with NASA publications concerns charts, particularly the lack of grids and the difficulty in reading them. Another is the availability of computer user manuals and better quality magnetic tapes or card decks to accompany computer programs. (100-103)

Dissemination. That information is not received when it is timely is cited by 66% of the executives and 62% of the researchers. Another area of inadequacy concerns information retrieval, particularly indexing systems and availability of access to NASA data banks. (103-106)

The Image of NASA Technical Publications

The multidimensional scaling portion of the study was undertaken to provide preliminary information on the image that industry scientists and technicians have of NASA technical information. The concept of "NASA technical information" was found to be relatively far removed from that of "my job." In other words, there are indications that the views of NASA technical information held by industry scientists and technicians are not closely associated with the views they hold of their work in the aerospace industry. Manipulations of the data revealed several message strategies which could be used to move the concept of NASA technical information closer to that of the jobs of researchers. Some of the concepts critical in developing these strategies should be: (1) for scientists, timely, problem-solving, ideas, and aerospace; and (2) for technologists, accessibility, useful, aeronautics, and basic research. (21-24, 109-123)

Recommendations

The study provided a great amount of information about the generation, dissemination, and utilization of NASA technical information. Both the data from the primary questionnaires and the conversations with executives provided a number of very positive assessments of NASA and its technical information products. The following recommendations, however, focus on those problem areas which need consideration and probably action by NASA.

These recommendations are organized in the same sequence as the data reported in the previous section on major issues and image of NASA technical information.

Content

Publication of State-of-the-Art Reports. Of all the publications produced by NACA, perhaps the most enduring were those on the state-of-the-art in major areas of specialization; executives and researchers report that this kind of publication is greatly needed today. On an annual basis NASA should produce one or more state-of-the-art publications which integrate past and current knowledge in the field. The selection of these topics should be based, at least in part, on input from companies in the industry regarding the types of information they most need. (129-130)

Providing Complete Data and Information in Reports. Executives and researchers report they need not only the specific types of information currently included in each NASA technical publication, but also occasional access to additional specialized information and data. NASA should review existing categories (i.e., test verifications and results, costs, operating performance, configurations, correlations and other parametric data, design considerations, and related information from other research activities), create standard formats, and develop criteria for specification of the data which should be included in these and other categories. In addition, reports should indicate a contact for additional data not published in the report. (126)

Publication of Interim Reports and Working Papers. These types of publications help make information available more quickly. In addition to progress reports, NASA should encourage project directors to develop working papers, perhaps less formal than existing TM's, covering the current status of a project. These should be distributed quickly and informally to the aeronautical community. One problem with existing interim reports, it was observed, is that for proprietary reasons not all relevant data is always included by the company conducting the research. For the organization conducting the research, this may provide some competitive advantages; at the same time when this type of information is not included in interim reports or TM's, it is a disadvantage to the industry as a whole. This issue involves, as do some others, the amount of time required to obtain detailed new findings. (130-131)

Publications on Trends, Developments, Research Needs, and Planning. These types of topics rank high as information needs, particularly but not exclusively, by executives. Industry personnel place great value on keeping abreast of the field in general as well as specialized aspects of it. NASA should develop an informal quarterly publication which is forward-looking, covering current directions and activities of NASA, the status of major projects, plans for new research projects, publication of major new reports, trends in the field in general and in specialized areas, and other information which will keep industry personnel up-to-date and assist with their planning functions. (131-132)

Presentation of Information

Relating Current Research to Past or Other Current Efforts. One of the major inadequacies of NASA publications, according to executives and researchers in the aeronautical industry is the failure to effectively relate a new research project to existing knowledge and similar projects being developed concurrently. In all research reports and other technical publications, a section should be included which synthesizes other major relevant information available within and outside NASA. An additional way to meet this need is to periodically produce compendia which are, in effect, indexes to information on specific topics which are available in the entire field. The recent work of the Air Force was cited as an example of effective work toward bringing together an existing body of knowledge. (132-133)

Organizing Data in Reports. To help provide greater clarity in NASA publications, NASA should establish guidelines for organization of information. Reporting should be more systematic, detailing how data was developed and what sources were used. Existing standards for projects contracted by NASA should be reviewed to assure greater consistency of these reports with those produced within NASA, which generally are more highly respected because of their thoroughness, organization, and completeness. Key information in reports should be highlighted both in summaries and in the reports themselves. In summary, NASA needs to review the existing manual of style, updating and distributing it, to facilitate the preparation of technical reports. (133-134)

Objectivity. NASA publications receive some criticism for what is perceived as a lack of total objectivity, primarily because research concepts sometimes appear to be oriented around "special interests." As projects are initiated, NASA should encourage broad literature searches which extend beyond NASA itself or contractor interests and which are reported in the final publication on the project. (134)

Abstracts and Summaries. To help executives and researchers cope with the great volumes of information currently available from a large number of sources, NASA should make sure that abstracts clearly describe the project, the data included in the publication, configuration information by manufacturer or model, and key concepts which are relevant and applicable to aeronautical companies. The summaries included in the reports themselves should have similar information, along with a section on definitions. (134-135)

Conclusions. The practice of not developing conclusions in all publications should be examined by NASA and new methods for developing conclusions should be explored. If the practice of not drawing definitive conclusions is continued, more stringent requirements should be adopted to ensure that reports do contain the breadth of information categories and depth of data needed by researchers to validate their own conclusions. (135-136)

Executive Summaries. Executives and researchers need different types of information and use information in different ways. To better serve the needs of executives, who currently are an audience highly underserved by NASA, a policy should be established within NASA of providing information developed specifically for executives in aeronautical companies. Executive summaries, for example, should be written for major research projects and automatically distributed to executives throughout the industry. (136)

Writing Style

Executives express some concerns with the formality or tutorial style of NASA publications, while researchers express concerns about the clarity of writing. Overall, NASA should encourage its authors to strive for a natural, direct, and clear writing style. For example, if a section is included on design concepts or considerations, it should be written in the language of designers, just as cost data should be written in the language of cost analysts. More specifically, NASA should update its manual of style for authors of technical publications. (137)

Format and Design

Graphs. The style and quality of NASA graphs generally are considered to be comparable to those of many federal agencies but not approaching new standards being set by other organizations, particularly private industry and research firms. Specifically, NASA should make a study of trends in the design of graphs, charts, and illustrative matter in order to produce more sophisticated work. In addition, grids should be used on graphs, and type size should be somewhat larger on some charts. (137-138)

Use of Microfiche. Resistance to use of microforms is relatively strong in the aeronautical industry primarily because of quality (legibility) of microfiche (particualrly com-fiche) and convenience. Until existing problems can be resolved, NASA should consider reducing the use of microfiche if costs of traditional print publications can be kept reasonably low. NASA also should place high priority on the examination of the quality control of com-fiche. (138-139)

Typography. Some NASA publications are highly legible and effectively designed, while others suffer from basic typographical problems including type size which is too small, type style which is too light, and line lengths which are inappropriate for the size and style of type. NASA should strive for better typographic and printing quality. This does not mean that all reports must be expensively designed and typeset but that legibility and general attractiveness (adequate white space, bookface type styles, and effective placement of elements on a page) be sought in all publications. (139)

<u>Distribution of Computer User Manuals, Magnetic Tapes, and Card Decks</u>. To reduce the time lapse between publication of reports on new computer programs and distribution of user manuals and accompaning magnetic tapes or card decks, NASA should re-examine current production and distribution methods. (140)

<u>Dissemination Methods</u>

<u>Timeliness</u>. Perhaps the greatest general issue identified equally by executives and researchers is that of timeliness of NASA technical information. NASA should initiate a study of the process of producing and distributing its publications, beginning with the completion of the project through the final production of a report. Related to this should be a study of the processes of ordering, shipping, receiving, storing, and disseminating information from STIF to company personnel. Finally, a manual should be produced for users in the industry on ordering procedures and how NASA p[illegible] are distributed. (140-141)

<u>Information Retrieval Systems</u>. Retrieving relevant information is one of the most frustrating tasks of a new research project. To help facilitate retrieval of information for the aeronautical industry, NASA should conduct a study to determine changes in or additions to current STAR categories and key word systems. As previously recommended, the quality of abstracts in STAR and SCAN should be improved. Further, NASA should consider the development of training programs for librarians and perhaps for researchers on assessing NASA

technical information. (141-143)

Development of Compendia. An alternative information retrieval system is the compendia created by the Air Force. NASA should explore methods of developing similar compendia or cooperating with other agencies to produce this type of publication. (143-144)

Extending Access to NASA's RECON System. NASA should consider, guided by results of a recent study which has been conducted with selected contractors, making this system inexpensively available to all NASA contractors and others in the aeronautical industry. (144)

Communication with Executives and Researchers

Contacts with NASA. Executive and researcher contacts with NASA personnel are considered extremely important. To further improve interaction between NASA and companies, a quarterly publication should by created which describes all on-going projects and the key contacts for each. NASA also should develop workshops or seminars for industry personnel; on alternate occasions these programs can be taken to companies and companies can attend the programs at NASA. All NASA technical reports should also contain information on whom to contact and where they may be contacted regarding aspects of a project. (146-147)

Image of NASA Technical Information. There are indications, while tentative, that scientists and technologists in aeronautical companies view NASA technical information as relatively distant from their jobs. To correct this situation, NASA should review the major dimensions by which it manages the production and dissemination of information and examine the major concepts which industry personnel use when evaluating NASA technical information. These concepts include timeliness, accessibility, usefulness, problem-solving, and basic research. One strategy could be to develop a brochure based on the concepts on how to use NASA technical publications. (147-148)

Chapter One

PURPOSE OF THE STUDY

Statement of the Problem

One of the primary functions of the National Aeronautics and Space Administration (NASA) is the production and dissemination of scientific and technical information. As part of its research and development activities, NASA personnel produce information for research publications, conferences, and personal consultations. These forms of information output serve as important input to the aeronautical and related industries. In a very real sense, this information forms a major portion of the foundation for advancement in the aeronautical industry.

To date, however, NASA has gathered very little systematic data from the aeronautical industry regarding their views of NASA technical information; consequently, it is difficult to determine how these consumers evaluate NASA and its research products. Furthermore, little is known about the internal use which the aeronautical companies make of the various NASA technical documents that they request.

Past studies have either examined the NASA Scientific and Technical Information System as a whole* or examined the usefulness of the NASA Information System to NASA personnel.** As yet, no attempt has been made to determine the usefulness of NASA technical information to those who use it in the aeronautical companies; neither has an attempt been made to obtain an evaluation of

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*See Simat, Helliesen and Eichner, Inc., Use of the NASA Scientific and Technical Information System - A Case Study Approach to Developing Information About Users. Draft Report, April 12, 1973.

**See Prior, H. E., An Evaluation of the Scientific and Technical Information System, Special Libraries, 66, 1975, 515-519.

specific NASA technical publications from the aeronautical industry.

Recent comments by executives and others in the aeronautical industry have indicated some dissatisfaction with the technical information received from NASA. Yet, without systematic feedback from its users, it is difficult to determine what the reasons for this dissatisfaction might be, how widespread it is, or what changes in NASA information products would make them more suitable to the needs of the consumer.

The present study is undertaken on the premise that the better the information that NASA has about its user population, the more effective NASA will be in disseminating information to this audience. The study is designed to acquire at least some of the information NASA needs to assess its information dissemination policies and procedures. It is intended that the information in this final report will assist NASA management in planning research that will be of maximum benefit to the development of the aeronautical community.

Objectives and Tasks

Two major objectives were established for the study:

1. To identify how NASA technical information is disseminated and utilized within aeronautical companies; and
2. To analyze the perceived quality and usefulness of NASA technical information by the users in the aeronautical industry.

This section describes the tasks necessary to accomplish these two major objectives.

Objective 1. To identify how NASA technical information is disseminated and utilized within aeronautical companies, it was first necessary to determine how information is received, stored, and distributed within the aircraft companies. This included determining: (1) the timeliness in receiving information from the source (NASA) to the company, either by automatic distribution or by individually ordering documents; (2) the physical location in each company where technical information is stored; and (3) the notification procedure within each company that the information is available for company users.

Second, it was necessary to identify direct and indirect users of information, along with differences in usage patterns. This was accomplished by comparing types of users at different levels in the company hierarchy, and identifying differences in the amount of communication by telephone, letters, and person-to-person that was desired.

Third, it was necessary to identify user characteristics affecting the use of technical information within companies, job classifications, or other situations. This included identifying demographic characteristics of executives, researcher/designers, and librarians.

Finally, it was necessary to identify types of information needs (content) and needed or desired methods of presentation (format). This was accomplished by summarizing open-ended responses about information needs, changes, benefits, and inadequacies of NASA technical information from present users.

Objective 2. To analyze the perceived quality and usefulness of NASA technical information by users in aeronautical companies, it was first necessary to obtain evaluations of the quality and usefulness of NASA and other technical information by direct users. This included obtaining evaluations of aeronautical documents generated by NASA authors by researchers, designers, engineers, and other direct users in the companies.

Second, it was necessary to identify ways in which NASA technical information aids the work of individuals within aerospace companies. This included determining levels of importance for various sources of information.

Third, it was necessary to compare the use of NASA technical information to other similar sources. This was accomplished by summarizing all possible information sources utilized by aeronautical executives and researcher/designers in doing their jobs.

Fourth, it was necessary to identify the major dimensions or criteria by means of which users make their evaluations. This was accomplished with a multidimensional scaling technique to measure distances between primary concepts and secondary concepts in order to plan an effective strategy for message generation.

Overall, the study attempted to identify both the benefits of NASA technical information to companies and individuals in them, and the possible areas of needed change in the generation, dissemination, and utilization of NASA technical information. Thus, the scope of the study included the writing and production of documents, the distribution system, and the actual use of the technical information by companies, as well as the evaluation of the quality of that information and its specific usefulness to companies in the aerospace industry. The study was also designed to provide the initial development of a systematic feedback system from users to NASA, to provide NASA with an organized, consistent monitoring system for continued evaluation over time.

Overview of the Study

This study included all private corporations which were subscribers to automatic distribution of NASA aeronautical publications in September 1978. From these 45 companies identified, 40 agreed to participate in the study. As described in Chapter Three (see pages 30-32), the 40 companies which participated ranged from very small (as few as 35 employees) to very large (more than 100,000 employees). The five companies which did not participate tended to be relatively small with limited use of NASA technical publications; none of the major aerospace or other related companies declined to participate.

Three groups of direct or indirect users were identified: executives (department managers, division heads, chief engineers, or others managing engineering and research and development); researcher/designers (engineers, designers, scientists, or technologists); and librarians.

A series of questionnaires was designed and mailed to members of each group. These questionnaires attempted to determine specific usage and general evaluation data. In addition, the most direct users of NASA technical information, researcher/designers, were given abstracts of NASA-produced aeronautical publications distributed during the ten-month period. Forms were included to obtain more specific evaluation data on a random sample of actual publications.

Following collection of these data, personal interviews were held with executives and senior managers in six companies throughout the United States. This series of in-depth interviews obtained additional information on questions raised by the mail survey responses, as well as senior-level insights on broader company information needs and relationships with NASA.

An additional research instrument was developed using a multidimensional scaling technique (MDS). This was administered in person to groups of scientists and technologists in the six companies visited for personal interviews.

Organization of this Report

Chapter One has provided a brief statement of the problem, review of the basic objectives and tasks, and an overview of the study. Chapter Two describes the methods, research procedures, and forms of analysis in detail.

Chapter Three details findings of the study. The chapter has been organized into (1) a brief introduction, (2) description of the sample, (3) assessment of NASA technical information, (4) major issues, and (5) the image of NASA technical information. Information obtained from the 30 personal interviews with executives is integrated into each section.

Chapter Four reports specific recommendations resulting from this study. In addition, an Executive Summary of this report has been developed. Copies of letters to participants, questionnaires, other research instruments, and the list of the 40 participating companies are contained in the Appendices.

Chapter Two

METHODOLOGY

Overall Research Design

Three research techniques were used to obtain data: (1) questionnaires, (2) personal interviews, and (3) multidimensional scaling (MDS). Each involved a number of steps.

Questionnaires:

1. Identifying corporations receiving automatic distribution from STIF of NASA-produced aeronautical publications.
2. Obtaining agreement of these companies in the aerospace industry to participate in the study.
3. Identifying within each company the (a) head librarian or other senior information specialist, (b) managers or other senior level executives heading departments or divisions likely to use NASA technical information on a regular basis, and (c) researchers, designers, and other scientists and technologists who directly use NASA technical information in their work.
4. Designing mail questionnaires for each of the three groups, including letters explaining the study and procedures and methods for returning completed questionnaires.
5. Identifying aeronautical publications produced by NASA itself, developing sets of abstracts of these publications, and designing an instrument for evaluating individual publications.
6. Receiving, coding, processing, and analyzing data.
7. Thanking those who participated for their cooperation.

Personal Interviews:

1. Selecting representative companies in the aerospace industry and identifying key senior level executives and department heads in each.
2. Developing a protocol interviewing form and conducting in-depth, in-person interviews.
3. Sending letters of appreciation both to a senior person in each company and those interviewed expressing appreciation for their time and the information they provided.

Multidimensional Scaling (MDS):

1. Identifying major concepts obtained through responses on open-ended questions in the mail questionnaires.
2. Designing an MDS research instrument and pre-testing it.
3. Administering the instrument in person to scientists and technicians.
4. Coding, processing, and analyzing data.

Once all data had been collected, a number of computer and other analyses were made; in addition, data obtained by each of the three different data-collection methods were related to each other. The final step was preparation of a set of recommendations.

Companies Receiving NASA Information

While companies may receive NASA information from a great number of sources, it was believed that the most regular users probably were subscribers to automatic distribution from STIF. These companies, then, became the population for the data reported here.

A list was obtained from STIF's computerized Registration and Product Control System (RPCS) of all domestic organizations currently receiving (in September 1978) NASA publications in hard copy (Class 1U) or microfiche (Class 7U) on automatic distribution. There were a total of 532 organizations, including government agencies, NASA centers, military branches, research companies, libraries, universities and schools, and corporations. A total of 70 private corporations and other similar organizations were identified.

Before the final selection was made of companies which would be studied, a second criterion was added. The STIF list of domestic automatic distribution subscribers identifies 11 subject divisions of publications. These subject divisions agree with the broad subdivisions appearing in STAR: Aeronautics, Astronautics, Chemistry and Materials, Engineering, Geosciences, Life Sciences, Mathematical and Computer Sciences, Physics, Social Sciences, Space Sciences, and General.

Because this study sought specific evaluations of individual publications issued over a period of time, and the total number of publications listed in STAR was in the hundreds, a decision was reached in conjunction with the technical monitor for this project to limit the companies in the study to those receiving automatic distribution in the aeronautical subdivision. A total of 45 companies out of the possible 70 met this criterion. Furthermore, approximately 80% of those 45 companies received publications in at least one other subject division as well as aeronautical. More than 50% of those companies were automatic subscribers to all 11 subdivisions.

The 40 companies which agreed to participate out of the possible 45 are considered the "major" corporate recipients of NASA publications for the purposes of this study. (See Appendix A for a list of the 40 participating companies.) As previously noted, the five companies which declined to participate tended to be smaller and limited users of NASA technical information; it does not appear that this greatly affected the findings of the study.

Time Period

The study officially began October 1, 1978, and the contract period ended July 31, 1979.

The STIF list from RPCS of all domestic organizations receiving NASA publications in Classes 1U and 7U was received in mid-October and reflected current subscribers at about that time. STAR Journals were obtained for the period of January through October of 1978. All publications evaluated in the study were issued during this ten-month period.

Initial contacts were made with the companies in November 1978. Questionnaires to executives, researchers and librarians in those companies were mailed in late January and early February 1979. The questionnaires were returned by March 1979. Personal interviews and the MDS research were conducted in May and June 1979.

Primary Questionnaire

Selection of Sample

The first contact regarding the study was made by a letter to a senior executive officer of each company, signed by the Director of Ames Research Center, and mailed from Moffett Field in California. These individuals, called key contacts, were identified by telephone calls to each of the 45 companies that met the study criteria. The letter introduced the project and requested the names of individuals in each of the following three groups:

1. Executives. The names of five top management people in charge of research, development, or advanced design were requested.

2. Researcher/Designers.* Twelve names of researchers, scientists, engineers, designers, or others who were direct users of NASA aeronautical information were requested from each company.

3. Librarians. One head or senior librarian or similar information specialist was requested.

After an appropriate amount of time, all companies which had not responded to the initial contact were telephoned. Of the 45 companies and the possible 792 individuals requested, 40 companies agreed to participate. A total of 643 librarian, executive, and researcher names were obtained.

Questionnaire Design

Three separate questionnaires, one for each type of respondent, were designed:

1. Executive Questionnaire. This contained questions to obtain data on the frequency of use of NASA publications, personal contacts with NASA personnel, and the timeliness, accessibility, and usage patterns of NASA publications. One series of questions sought comparisons between NASA and NACA. Another set of questions was aimed at providing data to compare researcher attitudes and

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*For the purposes of this report, further references to the researcher/designer group has been abbreviated to "researchers;" reference to the questionnaire for this group remains "researcher/designer."

behaviors with those of their supervisors. There was also a series of open-ended questions.

2. Researcher/Designer Questionnaire. The basic form was similar to the Executive Questionnaire, with the addition of questions related to the specific use of technical information. Open-ended questions, like those for the executive group, sought data on specific information needs, sources of information, benefits of NASA technical information, possible inadequacies of NASA publications, and recommended changes.

3. Librarian Questionnaire. This sought information about the library, including its relationship to other company libraries, number of volumes, number of employees, usage patterns by clients, outside sources from which information was obtained, and other general information. In addition, several questions about receipt, storage, and dissemination of NASA publications were asked.

All questionnaires requested basic demographic information about the respondent, including company name, years of service in the company and the aerospace industry, educational level, job title, and age. Each was mailed to the designated participant with a personalized explanatory letter.

In addition to the basic questionnaire for researchers, another set of materials was added:

4. Publication Evaluation Forms. This was in two parts. The first contained a random sample of 25% of the NASA-produced publications issued in the first ten months of 1978 (see the next section for a description of this procedure). Abstracts of the publications were provided and the participants were asked to indicate which ones

they had read or looked at. The second part contained forms for evaluating individual publications. This part gathered data on how the publications were obtained and used, along with specific evaluations of their value and quality. Each researcher was asked to select no more than ten publications to evaluate.

Other materials included in the mail questionnaire package were a cover letter, a return envelope for the completed questionnaire, and a reply card. Since the questionnaires were anonymous, the reply card, which was returned separately to the research staff when the respondent completed the questionnaire, provided a method for contacting those who did not return their completed questionnaires within the specified time period. In addition, the reply cards were used to send letters of appreciation to all who participated. Samples of cover letters, questionnaires, and publication evaluation materials are contained in Appendices B, C, and D.

Selection of Publications for Evaluation

The evaluation section of the Researcher/Designer Questionnaire was designed to obtain evaluative data on specific NASA publications. Between January 1, 1978, and October 31, 1978, a total of 340 publications in the aeronautical subdivision of STAR were listed which had been produced by NASA itself. Publications produced or distributed by NTIS, AGARD, or other agencies were not included.

An abstract for each of these 340 publications was reproduced from STAR. Because of the large number of abstracts and the presumed limits on the participant's time, four sets of abstracts were created. Each set contained a different 85 abstracts. The sets then were randomly distributed to researchers in the study. Thus, all 340 of the NASA-produced publications had an equal chance for evaluation, although no respondent was required to consider more than 85 abstracts. After indicating which of the 85 had been read or scanned, each researcher then was asked to select no more than ten for detailed evaluation. Ten evaluation forms were included in each questionnaire packet. A sample of the evaluation form for an article appears in Appendix C.

Table 1 indicates the distribution of the 340 publications by aeronautical subcategories.

Table 1. Aeronautical Subdivision Publications by Subcategories

Subcategories of NASA-Produced Aeronautical Publications		Number of Abstracts in Each Subcategory
01	Aeronautics (General)	16
02	Aerodynamics	129
03	Air Transportation & Safety	10
04	Aircraft Communications & Navigation	10
05	Aircraft Design, Testing, & Performance	40
06	Aircraft Instrumentation	5
07	Aircraft Propulsion and Power	91
08	Aircraft Stability and Control	24
09	Research and Support Facilities (AIR)	15
TOTAL PUBLICATIONS: January 1, 1978, to October 31, 1978		340

Questionnaire Response Rate

Table 2 indicates the actual number of respondents who received questionnaires, and the response rate for each group. The total response rate for the study was 90% for the companies and 70% for the individuals contacted. For a study of this nature this response rate should be considered quite high.

Table 2. Response Rate for Mail Questionnaires

Types of Participants	Questionnaires Mailed	Number Responding	Percent
Companies	45	40	90%
Individuals			
Librarians	50*	41	82%
Executives	192	134	70%
Researcher/Designers	401	275	69%
TOTAL INDIVIDUALS	643	450	70%

*One company supplied the names of divisional librarians because of decentralization of its library services.

Personal Interviews

Following collection, processing, and analysis of data obtained from the mail questionnaires, the second data collection phase was started: in-depth personal interviews.

From the 40 companies which participated in the study, six were selected for a series of in-depth personal interviews. The selection of the six companies was made in conjunction with the project technical monitor at Ames Research Center on the basis of size, area of specialization, years of using NASA information, and geographical location. The objective was to obtain a reasonably broad representation of types of companies in the aerospace industry. A list of those companies selected for personal visits is in Appendix E, along with an interviewing protocol form.

To arrange those interviews, the key contact identified for the mail questionnaires was called by telephone. The purpose of the visit was explained as a follow-up to the mail questionnaires to gain more or greater depth of data on some issues which were identified in the mail questionnaire phase of the study. Cooperation and arrangements made by the companies were excellent.

Each interview lasted about an hour and was conducted by a senior member of the Communimetrics staff, trained in interviewing techniques. Information sought in these interviews ranged from use of NASA technical information by the interviewee to overall departmental and company information needs and evaluations of NASA publications and relationships.

A total of 30 interviews in six different companies were conducted between late May and mid-June of 1979. Companies were located on the East and West Coasts, as well as in the Midwest. The number of employees in the six companies ranged from 8,000 to more than 100,000. Some companies had very broad relationships with NASA, and all were currently working on at least one NASA contract. Some companies were involved in manufacturing components and other corporations produced completed aircraft.

Multidimensional Scaling

Purpose of the Technique

Multidimensional scaling is a technique that has only recently been applied to the study of human communication. It is based upon the premise that an individual can identify the similarities (or dissimilarities) among a set of objects or concepts which, when arrayed in a multidimensional space, provide a good representation of the cognitive structure of that person (i.e., the way the person thinks about that topic). The relationship (similarity) between concepts is measured as a "psychological distance" using "psychological units" in a manner similar to the way that "physical distance" may be measured in metric or English units. Psychological concepts are viewed as being distant from each other in the same way that physical objects such as homes, cities, and aircraft are at varying distances from each other. Concepts that are viewed as identical would have zero distance between them just as adjacent physical objects are separated by zero distance; concepts that are viewed as similar have small distances separating them; concepts that are viewed as very dissimilar would be separated by large distances.

For example, respondents in this study were asked to indicate the difference (or distance) between the concepts "NASA Technical Information" and "My Job." Persons who make frequent use of NASA technical information in their jobs would indicate that these two concepts are quite close to one another, say 10 to 25 units apart. People who do not use NASA technical information in their jobs would indicate that the two concepts are quite far apart, say 500 to 700 units apart or, perhaps, even farther apart.

The study of communication assumes shared meaning for words. It is critical for this type of research that the concepts chosen are actual words and ideas used regularly by the group of respondents to be studied. The words or concepts can be obtained by listening to conversations, can originate from open-ended interviewing either in person or by telephone, or can be found in open-ended written responses on questionnaires.

Typically, participants in a multidimensional study are requested to estimate the distances among all of the concepts in a concept set, thus providing a full matrix of distances much like a table of inter-city distances often associated with road or air maps. These data may be analyzed from a variety of perspectives, but one of the most useful is to examine the relation between two primary concepts and the remainder of the set. This relation can be studied to determine a message strategy which can be used to reduce the distance between the two primary concepts; reducing this distance is equivalent to making the two concepts more similar in the framework of thinking of the persons involved. Thus, the selection of the primary concepts is crucial.

In this study, the primary concepts are "NASA Technical Information" and "My Job." The concept to be moved, called the start concept, is "NASA Technical Information;" the concept towards which the start concept is to be moved, called the target concept, is "My Job." The following section describes the multidimensional instrument developed for the present study.

<u>MDS Research Instrument</u>

As indicated above, the primary concepts used were "NASA Technical Information" and "My Job." The other eight concepts initially were obtained by reviewing the mail questionnaires and telephone interviews. These concepts were: timely, accessible, useful, adequate, respected, aeronautical, problem-solving, and ideas. Each of these ten concepts was paired with each of the others, for a total of 45 pairs. Respondents were asked to indicate the perceived difference (or distance) between each of the paired concepts.

The MDS instrument was pilot-tested with 26 researchers in the first of the six companies visited for personal interviews. The results from the pilot test were analyzed, and several changes were made before continuing with the other five companies. Two additional concepts were added: "aerospace" and "basic research." The final instrument contained 12 concepts, for a total of 66 different pairs. Also, the researchers were asked to choose a position on a 0 to 9-point scale describing their work-orientation in terms of "scientist" or "technologist." A "0" represented a "pure scientist orientation" and a "9" represented a "pure technologist orientation." A scientist was defined as a person who likes the theoretical aspects of ideas, theory development and construction from those ideas, and one who may have published and/or presented those ideas at scientific meetings. A technologist was defined as a person who applies theories to produce better products for the corporation or industry, and who enjoys applying new information to construct technical advances or improvements. (See Appendix F for a copy of the MDS questionnaires.) The purpose of distinguishing between scientists and technologists was to attempt to determine if there were basic differences in perception of the concepts and their relationships by the two groups. Some recent research has indicated differences in the methods of acquiring and using information between scientists and technologists.

In all six companies, respondents were chosen that were likely to have frequently used NASA technical information in performing their jobs. The instrument was administered in a group setting. A total of 101 completed MDS questionnaires was obtained from the remaining five companies. The first company was not included in the analysis because of the addition of the two concepts, and because the work-orientation scale (e.g., scientist vs. technologist) was not included in the pilot test.

Using a MDS computer analysis program, the data were processed separately for the "scientists" and "technologists." The scientist/technologists categories were determined by regrouping from the 9-point scale: position points of 0-6 were relabeled "scientists" (50% of the group), and position points 7-9 were relabeled "technologists" (50% of the group). Results are reported in the following chapter.

Data Analysis

The cut-off date for receipt of completed questionnaires was April 1, 1979. The 450 questionnaires received by that date were coded and the data were processed.

The questionnaire data were analyzed using subroutines in the Statistical Package for the Social Sciences (version 7.0) for the calculation of the frequencies, percentages, means, standard deviations, correlation coefficients, and other statistics included in this report. A separate computer program was employed for the multidimensional scaling analysis. All data were processed on the Control Data Corporation 6600 computer at Michigan State University.

Summary

This chapter described the methodology used in studying the dissemination and utilization of NASA technical information by executives, researchers and librarians in 40 aeronautical companies. Several research techniques were used: mail questionnaires to all three respondent groups, personal interviews with senior level executives and department heads in six of the 40 companies, and multidimensional scaling with a separate group of scientists and technologists in those same six companies. The criteria for choosing the sample of companies to be included in the study were discussed, the data collection techniques and the instrument designs were described, and the analyses were explained. The results of this work are discussed in Chapter Three.

Chapter Three

FINDINGS

ORGANIZATION OF THE CHAPTER

Chapter Three presents the major findings of the study. It is organized into four sections: description of the sample, assessment of NASA technical information, major issues, and the image of NASA technical information. The description of the sample provides the details of the companies and personnel that participated in the study. The section on the assessment of NASA technical information provides the results for the closed-ended items in the Executive, Researcher/Designer, and Librarian Questionnaires. The major issues section contains the results for the open-ended questions in the Executive and Researcher/Designer Questionnaires and for the personal interviews with the executives. The image of NASA technical information provides the results for the multidimensional scaling data obtained from the scientists and technicians.

Information obtained in the executive interviews has been integrated throughout the chapter to illustrate, amplify, or further clarify the data and concepts discussed, though it has been used most frequently in the section on major issues.

The section on major issues contains two levels of resolution. On the macroscopic level, data are reported about the four major open-ended questions asked: major information needs of the aeronautics industry, major benefits of receiving NASA technical information, major inadequacies in NASA technical information, and recommended changes. On the microscopic level, data are reported on major issues of direct relevance to the assessment of NASA technical information: content, presentation, writing style, format and design, and methods of dissemination. While these two levels of resolution in reporting the data are complementary, they are intended to provide different perspectives on the assessment of NASA technical information.

Rather than a general summary at the end of the chapter, each section contains its own summary and conclusions. This procedure has been employed because of the large amount of data reported in this chapter; it also makes it easier to inspect the data upon which the conclusions were based.

DESCRIPTION OF THE SAMPLE

This section of the report briefly describes the major features of the sample selected for the primary mail questionnaire part of the study. The 40 companies sampled ranged from as few as 35 employees in one company to more than 100,000 employees in several companies. The average number of employees was 31,997.

Table 3 shows the data describing the average years in the company, the average years in the industry, and the average age of the three primary groups in the study: executives, researchers, and librarians. The average age was middle to late forties, the average length in the industry was at least twenty years, and the average length in the company was fifteen years or longer. The executives were somewhat older than researchers and librarians (four years), had been in the industry three years longer than researchers, and had been in their particular company two years longer than the researchers and four years longer than the librarians.

Table 3. General Characteristics of Executives, Researchers, and Librarians in the Sample*

Characteristic	Executives	Researchers	Librarians
Average Years with Company	19 years	17 years	15 years
Average Years in Industry	23 years	20 years	(question not asked)
Average Age	49 years	45 years	47 years

*The data for this table come from the Executive Questionnaire, the Researcher/Designer Questionnaire, and the Librarian Questionnaire, items #3, 4, and 5.

Table 4 reports the data on the educational level of the respondents in the sample. All but 8% had earned a bachelor's degree. An additional 46% of the executives, 40% of the researchers, and 54% of the librarians had earned one or more MA degrees. Twenty-six percent of the executives and 24% of the researchers had also received the PhD degree; none of the librarians possessed a PhD degree. The table shows that the educational profiles of the executives and researchers are highly similar, with a few more executives having earned graduate degrees than researchers.

Table 5 presents the job titles reported by the respondents. The primary job titles listed by the executives were: Manager (43%), Director (26%), Vice President (8%), Chief Engineer (8%); one corporation President was also included in the study. For the researchers, the primary job titles were: Engineer (26%), Manager (24%), Researcher (17%), Section Head (8%), Chief Engineer (7%), and several other categories each of which totaled less than seven percent. Only one percent indicated that they were at the director level, and there were no presidents or vice-presidents in the researcher subsample. The primary job titles listed by the librarians were: Chief

Librarian (30%), Manager (25%), Librarian (23%), Supervisor (16%), and Technical Librarian (7%).

Table 4. Level of Education Comparisons for Executives, Researchers, and Librarians (Highest Degree Earned)*

Education Level	% Executives	% Researchers	% Librarians
PhD Degree	26	24	0
Work Toward a PhD	0	1	0
Two or More MA Degrees	3	4	2
Master's Degree	43	36	52
Work Toward an MA	< 1	1	0
Bachelor's Degree	24	31	36
Technical Degree	1	0	0
Other	1	1	0
No Degree	0	< 1	7
No Response	0	1	2

*The data for this table come from all three questionnaires, item #6.

Table 5. Job Title Comparisons for Executives, Researchers, and Librarians*

Title	Executives	Researchers	Librarians
Engineer	5%	26%	0%
Manager	43	24	25
Researcher	0	17	0
Section Head/Manager	3	8	0
Chief Engineer	8	7	0
Supervisor	3	6	16
Specialist	1	5	0
Chief Scientist	4	2	0
Staff Scientist	0	2	0
Director	26	1	0
Deputy Director	< 1	< 1	0
Assistant to Vice President	< 1	< 1	0
President	1	0	0
Vice President	8	0	0
Chief Librarian	0	0	30
Librarian	0	0	23
Technical Librarian	0	0	7
No Response	0	< 1	0
	100%	100%	100%

*The data for this table come from all three questionnaires, item #2.

ASSESSMENTS OF NASA TECHNICAL INFORMATION

This section reports the data obtained from the closed-ended questions of the primary mail questionnaires for executives and researchers. In addition, comments and information obtained from the personal interviews has been included in the text (the tables represent data from the questionnaires themselves). This section is organized as follows:

(1) Corporate Library Facilities

(2) Sources of Technical Information

(3) Sources for Learning About NASA Publications

(4) Frequency of Use of NASA Documents, NASA-Authored Journal Articles, and the Corporate Library by Industry Personnel

(5) Automatic Distribution vs. Selective Ordering of Documents

(6) Reasons for Not Receiving NASA Documents

(7) Effort to Obtain NASA Documents Within Companies

(8) Timeliness of NASA Technical Information

(9) Value of STAR Categories and Subcategories

(10) Evaluation of Specific NASA Aeronautical Publications

(11) Industry Communication with NASA Personnel

   a. Frequency

   b. Importance

(12) Executive Comparison of NASA and NACA

(13) Accuracy of Industry Executives' Views of their Employees' Relationships with NASA

Corporate Library Facilities

In order to provide part of the context in which this study's data were derived, it is helpful to briefly describe the library facilities (or information center facilities) within the companies represented in the sample. The data show that 32% of the companies have only one central library which serves the entire company. The remainder of the companies (68%) have divisional libraries in addition to a central library. In fact, data show that there is an average of 13 divisional libraries per company (see Librarian Questionnaire, items #7 and 8). This suggests that the storage and retrieval of technical information is important to companies and the functioning of their employees.

The average number of full-time librarians employed in a company is 11 and 23% of the companies employ part-time librarians as well (see Librarian Questionnaire, item #12). This further supports the important function libraries serve for aeronautical companies.

An average company library contains 104,910 books and journals. This ranges from as few as 100 volumes contained in a divisional library, to more than 585,000 volumes in a central library (see Librarian Questionnaire, item #11). This does not include the microfiche, manuals, newspapers, or technical memoranda which would also be located there.

There is an average of 12 microfiche readers in each company, with a range of from no microfiche readers to as many as 45 readers. Because some technical information is only available on microfiche copy, companies which have no microfiche readers or very few readers for their employees, will be at some disadvantage in obtaining the information they might need. Table 6 shows the distribution of microfiche readers and the percentage of companies containing that number.

Table 6. Distribution of Microfiche Readers by Company*

Number of Readers	Percentage of Companies
0	5%
1	11
2	9
3	11
4	9
5	9
6	14
7	5
8	5
10	2
12	2
22	5
25	5
40	2
45	2
No Response	5
	100%

*This table rpeorts the responses provided by 44 librarians to Librarian Questionnaire, item #22.

Sources of Technical Information

Sources of All Technical Information

NASA technical information does not exist in a vacuum, but rather in the context of all of the other, sometimes competing, technical information currently available. To place the role of NASA technical information into perspective, data were obtained about all major sources of technical information, including those from NASA, which aircraft industry personnel considered important in their work (see Executive Questionnaire, item #28, and Researcher/Designer Questionnaire, item #19).

Executives were asked the question, "Out of all the technical information publications your employees use, what do you consider to be the five most important publications in helping them do their work?" The researchers were asked the same questions about their own use of documents. A total of 1,698 responses were received on this question, 519 from executives and 1,079 from researchers.

Data are reported in Table 7. As a group, journals other than AIAA publications were listed as the most frequent sources of technical information by both executives (30%) and researchers (28%). NASA publications were the next most frequently listed source of technical information by both groups (25% and 22%). A variety of other publications such as company bulletins, textbooks, etc., were listed third (19% and 23%) for executives and researchers with AIAA publications listed fourth (11% and 13%). These data indicate that considering all of the technical information available to industry personnel, NASA technical information is considered highly important, second only to the major journals in the field considered as a group.

Sources for NASA Technical Information

The Librarians were asked to indicate the frequency with which they ordered NASA technical documents from various sources, whether on automatic distribution or by individual copies (see Librarian Questionnaire, item #19). Librarians were asked to mark all of the sources that applied. The data in Table 8 indicate that the two primary sources for obtaining NASA documents are NTIS (84%) and STIF (70%). DDC (52%) and NASA Research Centers (50%) were also mentioned by at least half of the librarians.

Table 7. Most Important Technical Information Publications Used by Executives and Researchers in Their Work*

Publications	% Executives	% Researchers
NASA and NACA Publications		
Technical Reports/Papers	8	7
TM's/CR's/TD's	5	4
STAR	3	4
Briefs/Memorandum	2	2
Contractor Reports	2	1
SCAN	1	1
NACA Publications	1	1
Other	3	2
TOTAL NASA AND NACA	25%	22%
AIAA Publications		
Journals	4	4
Technical/Symposia Papers	3	4
Journal of Aircraft	3	3
Other	1	2
TOTAL AIAA Publications	11%	13%
Other Journals		
Technical Society Journals	4	4
Aviation Week	4	3
Astronautics & Aeronautics	1	2
Journal of Fluid Mechanics	0	1
Other Technical Journals	4	3
Trade Magazines	0	2
Other Journals	17	13
TOTAL Other Journals	30%	28%
Air Force Publications	6%	5%
ASME Publications	4%	4%
IEEE Publications	4%	3%
AGARD	1%	2%
Other Publications (each chosen less than 1%), including abstracts, company bulletins, texts, etc.	19%	23%

*This table is based on a total of 1,698 responses, 519 from executives and 1,079 from researchers.

Table 8. Sources Used by Librarians for Obtaining NASA Technical Documents*

Source	Frequency	Percentage**
NTIS	37	84%
STIF	29	70
DDC	23	52
NASA Research Centers	22	50
University Microfilms	19	43
AGARD	13	30
Directly from Authors	11	25

*From Librarian Questionnaire, item #19. Results are based upon responses from 44 librarians.
**Librarians were free to mark more than one category; percentages, therefore do not total to 100%.

Librarians were also asked to provide specific estimates of the number of NASA documents ordered from different sources during 1978 (see Librarian Questionnaire, item #27). Estimates were obtained for all categories included in STIF. The data that are reported in Table 9 are the average number of documents ordered by corporate librarians from each source during 1978. The two most frequent sources for obtaining NASA documents were DDC with an average of 368 documents (42%) and NTIS with an average of 346 docuemnts (39%). The average number ordered directly from STIF (52) constituted only 6% of those ordered. Librarians indicated that the reason for the low number of documents ordered directly from STIF is that STIF provides documents only on automatic distribution. The data reported in Table 9 provide a much better picture of the source for obtaining individual copies of NASA technical publications than do the data reported in Table 8; clearly most of the individual copies ordered are obtained from DDC and NTIS.

Table 9. Average Number of Individual Copies of NASA Documents Ordered from Difference Sources by Librarians During 1978*

Source	Average Frequency	Percentage
DDC	368	42%
NTIS	346	39
STIF	52	6
NASA Research Centers	29	3
Directly from Authors	7	1
Other	75	9
TOTAL	877	100%

*See Librarian Questionnaire, item #27; data are the average number of documents reported ordered by the 44 librarians.

Sources for Learning About NASA Publications

An important question in the evaluation of the NASA distribution system is how (or where) industry users learn about NASA publications that are available through the system and are potentially useful for their work. Researchers (but not executives) were asked to indicate their sources for learning about NASA publications. Data are reported in Table 10.

The largest percentage of researchers (30%) indicated that they learn about NASA publications through newsletters typically prepared by their corporate library or information services; 21% said that they learn about NASA publications through the STAR Index. The next most frequently used sources of information about NASA publications were NASA contacts (15%) and reading journal articles (15%), followed closely by contacts with colleagues inside the company (12%). NASA Technical Brief/SCAN and contacts with other colleagues outside their own company were ranked at the bottom of the list with 4% and 2%, respectively.

Table 10. Rank Ordering of Researchers' Sources for Learning About NASA Publications*

Rank	Source	Percentage
1	Newsletters	30%
2	STAR Index	21
3	NASA Contacts	15
4	Reading Journal	15
5	Colleague Inside Company	12
6	NASA Technical Brief/SCAN	4
7	Colleague Outside Company	2
	No Response	1

*See Researcher/Designer Questionnaire, item #16.

These data suggest that the industry's corporate libraries and information services which prepare and distribute newsletters containing abstracts and bulletins about new NASA publications are a crucial link in the dissemination of NASA documents. The STAR index is also quite important in helping industry personally determine what is available. It also appears that the industry relies as heavily upon their direct contacts with NASA personnel as they do on reading journal articles.

Frequency of Use of NASA Documents, NASA-Authored Journal Articles, and the Corporate Library by Industry Personnel

Little is currently known about the frequency with which personnel in the aircraft industry read NASA documents and journal articles authored by NASA scientists. To provide information on this question, executives and researchers in the study were asked to indicate their use of NASA documents in the performance of their work. Researchers were also asked to estimate how often they read journal articles that are authored by NASA scientists and how often they use their corporate library. Data are reported in Table 11 where the numbers represent the average responses rounded to the nearest whole number.

Table 11. Frequency of Use of NASA Documents, NASA-Authored Journal Articles, and the Corporate Library by Industry Personnel

Question	Executives	Researchers
Frequency of use of NASA documents in performing their work	27/yr*	32/yr
Number of journal articles authored by NASA personnel read per year	QNA**	17/yr
Number of times per year they use the corporate library	QNA	41/yr

*Numbers represent the average (arithmetic mean) responses rounded to the nearest whole number provided by executives (see Executive Questionnaire, item #7a) and researchers (see Researcher/Designer Questionnaire, items #8a, 12a, and 7a).
**Question Not Asked.

Executives report using NASA documents on an average of 27 times per year which, assuming 240 working days per year, is roughly once every two weeks. Researchers report using them more frequently, 32 times per year or approximately once every seven days. Additionally, the researchers indicate that they read articles authored by NASA scientists about 17 times per year which averages out to about once every two weeks. The researchers also report that they use their corporate library 41 times per year, which is about once per work week. These data suggest that executives in the aircraft industry read NASA documents about twice a month and researchers read a NASA document or journal article authored by NASA scientists roughly once per week.

According to the librarians, the average number of employees served by the library in a company was 5,782. During a typical month, an average of 1,206 employees (21% of the 5,782 employees) actually use the library (see Librarian Questionnaire, items #10 and 15). When the librarians were asked to estimate the number of people who read NASA publications in a typical month, either in the library or elsewhere (see Librarian Questionnaire, item #21), they responded with an average of 234 people, 4% of the total number served.

The comparisons of the librarian, executive, and researcher data indicate some discrepancy about frequency of use of NASA documents; i.e., the librarians indicate a lower amount (4% of the number possible) than do the executives or researchers. However, it is difficult to determine whether this is significant because data are not available about the actual number of researchers or executives in a company. For example, the 4% of the users may be those actually represented in the respondent sample for this study, or it may indicate that the executives and researchers are overestimating their frequency of use of NASA documents.

Automatic Distribution vs. Selective Ordering of Documents

The participants in the study were asked how many times during the past year they personally ordered a document from NASA. In the case of the executives, they were asked how many times they ordered documents directly from a NASA research center; the researchers were asked how many documents they had ordered directly from NASA or a NASA research center. The results are shown in Table 12.

Table 12. Number of NASA Documents Personally Ordered Directly from NASA or a NASA Research Center in the Past Year*

Number of Documents Ordered	Executives	Researchers
0	48%**	43%
1	11	9
2	16	14
3	5	9
4	4	7
5-10	10	13
> 10	5	5
Average number ordered (between 1 and 10)***	3.15	3.52

*This table reports data from the Executive Questionnaire, item #19 and the Researcher/Designer Questionnaire, item #15. The wording of the two versions of the question is slightly different (see text for discussion).

**The numbers should be read as the percentage of persons indicating that during the past year they ordered the number of documents listed in the left hand column.

***These averages are for those who ordered at least one document during the past year (i.e., subtracting out those who did not order any documents); those in the category > 10 were also subtracted out in order to control for the effect of outliers on the mean.

Nearly half (48%) of the executives indicated that they had not ordered any documents over the past year. Almost as many researchers (43%) reported the same fact. The number of documents ordered by the largest percentage of executives (16%) was two; the number of documents ordered by the largest percentage of researchers (14%) was also two. An average (arithmetic mean) was calculated for those who had ordered between one and ten documents. (The five in each group who had ordered more than ten documents were deleted from the analysis to control for the effect of extreme scores on the mean.) As Table 12 indicates, the executives ordered an average of just over three documents last year, while the researchers ordered just over three and a half documents each.

Table 13 provides the categories of NASA technical information received on automatic distribution by the companies in the present study. All the companies receive at least half of the categories, with the categories of aeronautics, engineering, and math and computer science received most frequently. Astronautics, geosciences, and space sciences are received least frequently on automatic distribution.

Table 13. Automatic Distribution and Individual Ordering of NASA Technical Information in STAR Categories*

Category	% of Companies Receiving	% of Companies Ordering
Aeronautics	77%	32%
Engineering	73	27
Math and Computer Science	71	30
Chemistry and Materials	68	27
Physics	66	23
Social Sciences	59	16
Life Sciences	57	21
Astronautics	55	23
Geosciences	55	16
Space Sciences	52	30

*This table reports data from the Librarian Questionnaire, items #17 and 18.

In addition to receiving documents on automatic distribution, almost two-thirds (61%) of the companies order indiviudal copies, primarily because of employee requests for specific information. Table 13 also indicates the categories ordered individually by company libraries. The data indicate that the categories of aeronautics, math and computer science, and space science are ordered most frequently. Life science, geoscience, and social science are individually ordered least frequently.

When librarians were asked who orders individual copies of documents requested by an employee (see Librarian Questionnaire, item #23), 91% of the librarians responded that only the library does the ordering. The data indicate that 77% of the companies have a company policy that only the library does the ordering (see Librarian Questionnaire, item #24).

Reasons for Not Receiving NASA Documents

The librarians indicated that often a NASA document is specifically requested by an employee but it is not available in the company library. During 1978, several reasons were given for this unavailability when a document is needed. Table 14 summarizes the reasons given by librarians, and indicates the percent of times this has occurred. According to the table, the most frequent reason is that the document was referenced in STAR but is not on automatic distribution (55% of the time).

The cost of subscribing to automatic distribution was also considered as a possible reason for not receiving NASA documents. Data were collected using a seven point scale ranging from "1" (very unimportant) to "7" (very important). Librarians were asked to determine how important cost is in deciding to continue on automatic distribution. Data are reported in Table 15. The responses have been grouped into four categories: very unimportant (options 1 and 2 on the scale), unimportant (option 3), important (option 5), and very important (options 6 and 7). The data indicate that half (49%) of the librarians perceive cost as a factor in determining whether their company receives NASA technical information on automatic distribution.

Table 14. Reasons Provided by Librarians for Not Receiving NASA Documents*

Reasons	Percent
The document was referenced in STAR but was not on automatic distribution.	55%
The document was supposed to be in the automatic distribution package but was never received.	20
The document was not in the STAR Index subject categories received on automatic distribution.	11
Additional copies were not available.	9
The copy was lost.	4
The company only receives hardbound copies on automatic distribution, and the document was available only on microfiche.	1
	100%

*This table reports data from the Librarian Questionnaire, item #26.

Table 15. Importance of Cost as a Factor in Receiving Automatic Distribution*

Importance Level	Percent of Librarians
Very unimportant (1-2)**	21%
Unimportant (3)	16
Important (5)***	14
Very important (6-7)	35

*Data in this table come from the Librarian Questionnaire, item #29.
**A seven interval scale ranging from "1" for "very unimportant" to "7" for "very important" was used to obtain the data. Responses are reported here which combined the categories as shown by the numbers in parentheses.
***To simplify the table, the percentages in the middle category, neither important nor unimportant (4), are not included above. This middle category figure is 14%.

Effort to Obtain NASA Documents Within Companies

It is a common occurrence in organizations for important information to be ignored simply because employees perceive that it requires too much effort to obtain it. In order to ascertain the amount of effort required to obtain NASA information, the respondents were asked to indicate how much effort it took for them to acquire it from within their own organization. The qualifier "within their own organization" should be emphasized, since the focus of the question is on the respondent's own organization, rather than the effort it takes to obtain NASA documents directly from NASA. Thus, regardless of whether it is easy or difficult to obtain documents directly from NASA, if company policy dictates that employees utilize their corporate library facilities rather than ordering documents directly, and if that process does not work well, then one potential problem source in distributing NASA information to aircraft industry personnel could well be the companies themselves.

Data were collected using a seven point scale ranging from "1" representing "very little effort," to "7" representing "very much effort." Executives were asked to estimate the effort required on the part of their employees; researchers reported on their own experience in obtaining NASA documents through their organizations. Data for this item are reported in Table 16. The responses have been grouped into three categories: very little effort (options 1 and 2 on the scale), moderate effort (options 3, 4, and 5), and very much effort (options 6 and 7). The arithmetic mean for both executives and researchers is also reported.

Table 16 indicates that 51% of the executives think that their employees have very little effort obtaining NASA documents within their company; 73%

of the researchers report very little effort. Forty-five percent of the executives believe that their employees must expend a moderate amount of effort to obtain documents, but only 23% of the researchers report that they need to spend a moderate amount of effort. Only 4% in either group indicated that a great deal of effort was required to obtain the documents. The mean of the effort ratings for executives was 2.76 and for the researchers 2.22.

Table 16. Effort to Obtain NASA Documents Within Companies*

Amount of Effort	Executives	Researchers
Very little effort (1-2)**	51%	73%
Moderate effort (3-5)	45	23
Very much effort (6-7)	4	4
Average amount of effort***	2.76	2.22

*Data from Executive Questionnaire, item #18 and Researcher/Designer Questionnaire, item #13. Executives were asked to estimate the effort required for their employees; researchers reported their own views.

**A seven interval scale ranging from "1" for "very little effort" to "7" for "very much effort" was used to obtain the data. Responses are reported here which combined the categories as shown by the numbers in parentheses.

***The data in this row report the average (arithmetic mean) for each of the two groups.

The percentages and the averages indicate that employees need to spend relatively little effort to obtain NASA documents through their companies. Furthermore, the executives appear to think that their employees expended somewhat more effort than the employees report actually spending. While the difference is not large, this finding does suggest that companies' information services may be working more effectively than executives realize. These data also suggest that the companies themselves are not a major source of problem for the distribution of NASA documents, at least from the perspective in industry personnel.

Most of the executives interviewed in person gave their libraries high grades for their ability to obtain information needed, reporting that from 75% to 90% of the time their librarians either have the information available within the company or are able to obtain it in a reasonable amount of time from outside sources.

Timeliness of NASA Technical Information

Highly competitive fields such as the aircraft industry rely heavily on the rapid acquisition and utilization of new technologies. Putting aside the question of whether NASA is producing the needed new information, the question remains as to whether the new information which is currently available within NASA is being disseminated in time to be of use to the industry. Thus, the focus of this section is on the timely dissemination of information and not on the creation of information.

Researchers were asked to indicate how timely the information was that they receive from NASA; executives were asked the same question with respect to the information received by their employees. The responses are provided in Table 17 and show a reasonably consistent pattern. Twenty-six percent of the executives and 30% of the researchers indicate that they receive the information during the beginning or planning stages of their projects; 65% of the executives and 58% of the researchers indicate that they receive it while they are working on or are in the middle of the project. Only 8% of the executives and 11% of the researchers indicate that they receive information too late in the project to be of use in their work.

Table 17. Timeliness of NASA Technical Information*

Responses	Executives	Researchers
Receive information in beginning or planning stages.	26%	30%
Receive information during the middle of the project.	65	58
Receive information after it is too late to use.	8	11

*This table reports the responses provided by 144 executives to Executive Questionnaire, item #17, and by 289 researchers to Researcher/Designer Questionnaire, item #14.

These findings suggest that NASA is doing a reasonably good job in getting the information it produces to the aircraft companies before it is too late to be of use in the companies' projects. They also suggest that the expenditure of some effort may be justified in order to get more of the information to the companies during the planning/beginning stages of the project, rather than during the working phase.

Librarians were asked how long it takes to receive a NASA document after it has been released or ordered. Table 18 indicates that it takes an average of 19 days to receive a NASA document, with a range from nine to 30 days. No data are available on the length of time it takes to receive documents that are ordered directly from NASA (i.e., not on automatic distribution).

Table 18. Length of Time to Receive NASA Documents on Automatic Distribution*

Number of Days to Receive	% of Librarians Responding
9	5%
10	9
14	18
15	5
16	2
17	2
18	2
20	7
21	21
25	9
27	2
28	2
30	9
No Response	7
	100%

*This table reports the responses provided by 44 librarians to Librarian Questionnaire, item #25.

Value of STAR Categories and Subcategories

In order to provide NASA with information pertaining to the relative value of the various STAR categories and subcategories, participants in the study were asked to rank order the ten categories in STAR and the nine subcategories in the aeronautics category in terms of their usefulness and value. Executives were asked to perform the evaluations on the basis of the benefits for their own company; researchers were asked to rank the categories in terms of the benefits for performing their own work.

Data for the value of the STAR categories as ranked by both executives and researchers are shown in Table 19. The rankings are remarkably similar. Aeronautics, engineering, and mathematics and computer science were the top three ranked categories for executives; researchers also chose engineering, aeronautics, and mathematics and computer science as the three most valuable categories, though they chose the first two in the reverse order from that of the executives. The only real difference in the ranking was on the category of chemistry: executives ranked it fourth with a mean of 4.4, while researchers ranked it seventh with a mean of 5.8. The bottom three ranked categories for both groups were geophysics, life science, and social science.

Table 19. Comparison of Order of Value of STAR Categories*

Executives			Researchers		
Rank**	Category	Mean Rating	Rank	Category	Mean Rating
1	Aeronautics	2.7	1	Engineering	2.6
2	Engineering	3.0	2	Aeronautics	3.3
3	Mathematics and Computer Science	4.0	3	Mathematics and Computer Science	4.4
4	Chemistry	4.4	4	Astronautics	4.9
5	Astronautics	4.7	5	Physics	5.0
6	Physics	5.1	6	Space Science	5.4
7	Space Science	5.5	7	Chemistry	5.8
8	Geophysics	7.5	8	Geophysics	7.6
9	Life Science	7.51	9	Life Science	8.2
10	Social Science	9.0	10	Social Science	9.2

*From Executive Questionnaire, item #26, and Researcher/Designer Questionnaire, item #17.
**"1" represents most valuable and "10" least valuable.

Data for the comparative value of the Aeronautical subcategories are shown in Table 20. Both executives and researchers indicated that aerodynamics and aircraft design are the first and second most important categories. Both groups ranked aircraft stability, general aeronautics, aircraft propulsion and aircraft research as third through sixth in importance, though they did so in different order. The largest difference in ranking was for aircraft stability; executives ranked this subcategory third in importance with a mean of 4.2, while researchers ranked aircraft stability as fifth in importance with a mean of 5.0. The three least important categories were aircraft instrumentation, transportation, and communication.

Table 20. Comparison of Order of Value of Aeronautics' Subcategories*

Executives			Researchers		
Rank**	Category	Mean Rating	Rank	Category	Mean Rating
1	Aerodynamics	2.9	1	Aerodynamics	3.4
2	Aircraft Design	4.1	2	Aircraft Design	3.7
3	Aircraft Stability	4.2	3	Aeronautics General	4.1
4	Aeronautics General	4.4	4	Aircraft Propulsion	4.8
5	Aircraft Propulsion	5.0	5	Aircraft Stability	5.0
6	Aircraft Research	5.5	6	Aircraft Research	5.2
7	Aircraft Instrumentation	5.6	7	Aircraft Instrumentation	6.8
8	Aircraft Communication	6.0	8	Aircraft Transportation	7.1
9	Aircraft Transportation	6.1	9	Aircraft Communication	7.2

*From Executive Questionnaire, item #27, and Researcher/Designer Questionnaire, item #18.
**"1" represents most valuable and "9" least valuable.

Evaluation of Specific NASA Aeronautical Publications

This section reports the results of the assessments made by industry personnel of specific NASA aeronautical articles issued during the first 10 months of 1978 that they had read. For each article they evaluated, respondents were asked to indicate where they learned about the article, how much they had read, whether they had referenced the article in a publication, and their assessment of the article on nine dimensions. It is important to emphasize that unlike previous studies (as well as the other sections of this study) respondents were evaluating specific NASA publications they had read.

In Chapter Two it was indicated that there were 340 articles listed in STAR for the time period of the research; each respondent was asked to review only one-fourth of the sample, or 85 articles. Researchers indicated having read or seen 257 of the 340 articles or 76%. They evaluated 232 of the 257 articles (or 68%) of the population of 340 articles. Table 21 indicates how many times each of the articles was evaluated. Slightly less than half of the articles were evaluated once. Twenty percent of the articles were evaluated by two respondents; 15% of the articles were evaluated by three respondents. The most number of times any one article was evaluated was seven, but that occurred only 1% of the time. The number of times each article was evaluated can be converted into the total number of evaluations made across the entire set of documents, which is reported in the final column of the table. As can be seen, a total of 500 article evaluations were received.

Table 22 reports the number of times that documents within each of the subcategories of "aeronautics" were evaluated. The largest number of evaluations were received for documents in the aerodynamics and propulsion categories. These figures give a good indication of the relative importance of each of the subcategories to the sample of respondents.

Table 21. Number of Evaluations of Specific NASA Aeronautical Articles*

Number of Evaluations per Article	Frequency	Percentage	Total Evaluations
One	111	48%	111
Two	47	20	94
Three	35	15	105
Four	18	4	72
Five	10	4	50
Six	9	4	54
Seven	2	1	14
Total	232		500

*Data from Researcher/Designer Questionnaire.

Table 22. Number of Evaluations of NASA Technical Articles by "Aeronautics" Subcategories*

Subcategory	Number	Percentage
Aerodynamics	203	41%
Propulsion	119	24
Design	57	11
Stability	47	9
General Aeronautics	33	7
Communication and Navigation	13	3
Transportation and Safety	12	2
Research and Support	9	2
Instrumentation	7	1
Total	500	

*Data from Researcher/Designer Questionnaire

Respondents were asked to indicate how they first became aware of each of the documents they evaluated. Data are presented in ranked order in Table 23 and show that the researchers became aware of NASA documents most frequently through communication within their own organization (30%). The second most frequent way of learn about NASA documents was through STAR (21%). The third most important form for learning about documents was through face-to-face communication with NASA personnel (11%). Of all remaining sources, each was used less than 10% of the time.

Table 23. Rank Order of Sources for Learning About Specific NASA Aeronautical Articles*

Rank	Source	Percentage
1	Communication with colleagues in own organization	30%
2	Abstract in STAR	21
3	Face-to-face communication with NASA personnel	11
4	Abstract in SCAN	8
5	Corporate library publication	7
6	Technical journal	3
7	Telephone communication with NASA personnel	3
8	Communication with colleagues in other organizations	3
9	Abstract in IAA	1
10	Written communication with NASA personnel	1
11	Miscellaneous	12

*Data from Researcher/Designer Questionnaire, Abstract Evaluation, item #1.

In order to determine the amount of the article actually read that each assessment was based upon, as well as to provide information on the extent to which articles are read, respondents were asked to indicate what percentage of each article they had read. Data are presented in Table 24. Almost half of all respondents (47%) reported having read all of the document they evaluated and 80% reported reading half or more of the document. Only 20% evaluated documents of which they had read less than half. Although not all NASA documents may have been read this closely, it appears that the documents evaluated for this study had been extensively examined by the researchers.

Table 24. Amount of NASA Aeronautical Articles Read*

	less than one-tenth	one quarter	half	three quarters	all
Amount read	10%	10%	22%	10%	47%

*Data from Researcher/Designer Questionnaire, Abstract Evaluation, item #11.

Researchers also indicated the frequency with which they referenced the specific NASA technical articles they were evaluating in an in-house publication or in a technical publication. The data in Table 25 indicate that three-fourths of the respondents had not referenced the NASA technical articles in an in-house publication, 13% referenced it once, 9% twice, and the remaining 4% referenced it three or more times. With regard to other technical publications, 91% indicated not having cited the articles, 4% referenced them once, and another 4% referenced them twice.

Table 26 contains a summary of the data reported by the respondents in evaluating specific NASA documents. Respondents used a scale ranging from "1" for "very unimportant" to "7" for "very important" to evaluate each article on nine dimensions. Data in the table have been grouped into four categories by the scale numbers shown in parentheses below each evaluation category. Clearly the respondents saw the most important aspect of the articles they evaluated as maintaining their professional awareness; 71% said that the articles were important or very important for this function. Equally as clearly, the respondents indicated that the articles were unimportant for saving their company money and for saving person hours on the work project; 24% said they were important for saving money, 31% said they were important for saving time.

Table 25. Extent of References of NASA Aeronautical Articles in In-House and Other Industry Technical Publications*

	not referenced	once	twice	three or more times
Referenced in an in-house publication	74%	13%	9%	4%
Referenced in a technical publication	91%	4%	4%	2%

*Data from Researcher/Designer Questionnaire, Abstract Evaluation, items #9 and 10.

The remaining six evaluation dimenions are somewhat more complex to interpret. Respondents indicated that two of the dimensions were somewhat more important than unimportant: providing new ideas (46% to 34%) and validating their own research (43% to 38%). On the other four dimensions, respondents indicated that the articles were somewhat less important than unimportant: preventing duplication of work (40% to 44%), improving the quality of work (39% to 41%), helping to apply their own ideas (38% to 41%), and suggesting alternative methods (37% to 43%).

Taken together, these data indicate that industry personnel consider NASA technical publications more important for maintaining professional

Table 26. Evaluation of Specific NASA Aeronautical Documents

Rank	Evaluation Dimension	Very Unimportant (1)	Unimportant (2-3)	Important (5-6)	Very Important (7)
1	Maintaining professional awareness*	4%	12%	54%	17%**
2	Providing new ideas	12	22	40	6
3	Validating own research	14	24	34	9
4	Preventing duplication of work	20	24	33	7
5	Improving the quality of work	16	25	35	4
6	Helping apply own ideas	16	25	35	3
7	Saving person hours	33	22	27	4
8	Saving organization's money	32	28	20	4

*The first seven items are based upon 475 to 494 responses; saving person hours is based on 249 responses; saving money is based on 233 responses.

**To simplify the above table, the middle category, neither important nor unimportant (4), is not included. The percentages for this category are, beginning with the first item: 1. 13%, 2. 20%, 3. 19%, 4. 84%, 5. 20%, 6. 21%, 7. 14%, 8. 16%.

awareness, as a source for new ideas, and as a way to validate their own research. Important, though somewhat less so, are helping apply their own ideas, preventing duplication of work, suggesting alternative methods, and improving the quality of work. Least important are saving time and money in the work project.

Industry Communication with NASA Personnel

Frequency

Reading technical publications and articles is not the only way in which industry personnel learn about research findings and projects being generated by NASA. Various forms of direct, personal communication with NASA personnel are an important, and in some cases the primary, source of new information. Yet little is known about the frequency and importance of these communication and information links, especially from the viewpoint of industry personnel. Consequently, executives and researchers were asked to estimate the frequency with which they communicate with NASA personnel (see Executive Questionnaire, items #8a - 10a, and Researcher/Designer Questionnaire, items #9a - 11a) and to indicate the importance of the various forms of contact. The data on frequency of contact are reported in this section; the data on the importance of the contacts are discussed in the following section.

Three types of contacts were examined: (1) direct face-to-face communication, (2) telephone conversations, and (3) written correspondence. The results are presented in Table 27, where the data are reported separately for the two groups, and as averages (rounded to the nearest whole number) per year. Both groups were free to estimate their frequency of contact either by month or by year.

Table 27. Frequency of Executive and Researcher Communication with NASA Personnel

Type of Communication	Executives	Researchers
Direct, face-to-face communication	16/yr*	8/yr
Telephone conversations	22/yr	19/yr
Written correspondence	10/yr	7/yr
Totals	48/yr	34/yr

*Numbers represent the average (arithmetic mean) responses rounded to the nearest whole number provided by executives (see Executive Questionnaire #8a - 10a) and by researchers (see Researcher/Designer Questionnaire #9a - 11a).

For face-to-face communication, the executives reported an average of sixteen contacts per year, while the researchers reported only half as many contacts per year (8 contacts). Executives and researchers had about the same level of frequency of telephone conversations with NASA personnel; 22 per year for the executives and 19 per year for the researchers. Executives reported corresponding with NASA personnel slightly under once per month (10 times per year), while researchers reported corresponding at about half that rate, seven times per year.

As the final line of Table 27 indicates, when all three forms of communication are combined, the average number of total contacts per year is 48 for executives and 34 for researchers. In other terms, this averages out to around one contact per week by executives and one every ten days or so for researchers.

Importance

To indicate how they viewed the importance of their communication with NASA personnel for all three types of communication, respondents were provided a seven point scale which ranged from "1" representing "very unimportant" to "7" representing "very important." The data are presented in Table 28, where the numbers on the seven point scale have been combined into four categories: very unimportant, items 1 and 2; unimportant, item 3; important, item 5; and very important, items 6 and 7. Data are reported as percentages of the total number of executives and researchers responding to each question; there are less than 1% unusable data for each question.

Executives report that direct, face-to-face communication is very important (42%) and twice as important as written correspondence (21%) with NASA personnel. The same result also holds, though not quite so strongly, for the researchers; 38% said face-to-face communication was very important while only 22% said that written communication was very important. A third of the executives (35%) indicated that the telephone was a very important means of communication with NASA personnel, while 40% of the researchers indicated that it was very important. Executives consider face-to-face communication more important than telephone communication (42% to 35%), but researchers see it as about the same in importance (38% for face-to-face versus 40% for the telephone).

When Tables 27 and 28 are examined together, several findings emerge. Executives communicate twice as frequently by telephone as by face-to-face communication, but they consider face-to-face communication to be more important. Executives write less frequently to NASA personnel than communicate orally, and they consider writing much less important. Researchers have face-to-face communication with NASA personnel only about half as frequently as executives, but they rate it almost as high in importance. They speak on the phone a little less frequently than do the executives, but they rate it

Table 28. Evaluation of Importance of Communication with NASA Personnel*

Type of Communication	Executives	Researchers
Direct, face-to-face		
Very unimportant (1,2)**	25%***	30%
Unimportant (3)	6	5
Important (5)****	16	16
Very important (6.7)	42	38
Telephone		
Very unimportant	26%	28%
Unimportant	6	5
Important	16	16
Very important	35	40
Written correspondence		
Very unimportant	37%	38%
Unimportant	11	8
Important	21	14
Very important	21	22

*This table reports the responses provided by 144 executives to Executive Questionnaire, items #8b - 10b and by 289 researchers in Researcher/ Designer Questionnaire, items #9b - 11b.

**A seven point scale ranging from "1" for "very unimportant" to "7" for "very important" has been divided into four categories as indicated by the numbers in parentheses.

***All percentages total to 100% which constitutes the number of people answering the question. In almost all cases there was less than 1% of "no response," wrong codes, or missing data.

****To simplify the above table, the percentages are not reported for the middle category, neither important nor unimportant (4). These percentages are: Direct, face-to-face, 11% for executives and researchers; Telephone, 18% for executives and 11% for researchers; and Written Correspondence, 10% for executives and 18% for researchers.

higher in importance than do the executives and higher in importance than they rate face-to-face communication. Researchers do not write frequently to NASA personnel, even less than do the executives, and they do not consider it a very important form of communication. One plausible explanation for this finding offered by a number of executives in the personal interviews is the necessity for quickly obtaining information when a company is working on a project; typically, written requests take the greatest amount of time and are, consequently, often the least desirable.

The executives made a number of other observations during the personal interviews which are relevant to the communication between NASA and the aircraft companies. Most executives indicated that they thought the direct contact between the two was highly important. Though they recognized the financial constraints on both NASA and their own firms, most thought that an increase in direct, personal contact would be desirable and beneficial. Several executives felt that NASA and the companies ought to visit each other on an equal frequency rather than the industry visiting NASA most of the time as is currently the case.

When asked about the objectives that such visits ought to accomplish, executives said such things as "keep the companies abreast of current NASA projects and the state of the art," "teach new techniques and help industry personnel develop technical understanding in specific subject areas," "discuss objectives, schedules, resources and problems pertaining to future contract areas," and "discuss problems of contracts in progress."

One executive indicated that NACA had a "committee" with people from NACA, universities, and industry which met a couple of times per year. It produced a newsletter which was informal but focused on the relative importance of various research endeavors. Though it had the image of a think tank, it greatly benefited the industry by evaluating different ideas and communicating that to the aeronautical industry. While he recognized that other committees exist today, he felt that this particular "prioritizing" function has disappeared in recent years and should be reinstituted.

Executive Comparison of NASA and NACA

Executives, particularly those who have been a part of the aircraft industry for more than 25 years, sometimes have occasion to compare the functioning and performance of NASA with its predecessor, the National Advisory Committee on Aeronautics (NACA). In order to determine how NASA is viewed relative to NACA, industry executives were asked to respond to five questions which compared the two organizations (see Executive Questionnaire, items #21 - 25). The same issue was also discussed in the executive personal interviews. In this section we report the findings from both the questionnaires and the interviews.

Of the 144 executives in the study, 90 (63%) indicated that they had direct, personal experience with NACA. The data for the responses by the 90 executives to the five questions are reported in Table 29. The first question asked whether the executives thought it is easier for their employees to apply the information found in the present NASA publications than it was in the earlier NACA publications. Twenty-seven percent strongly agreed and another 21% mildly agreed that present NASA publications are easier to apply than the earlier NACA ones. Only 20% either strongly or mildly disagreed with this item. These data indicated that the executives generally feel that their employees find it easier to apply information found in NASA publications than that which was contained in NACA publications.

Table 29. Executive Comparison of NASA and NACA*

Statement	Evaluation**			
	Strongly Agree (1-2)	Mildly Agree (3)	Mildly Disagree (5)	Strongly Disagree (6-7)
Easier to apply information found in NASA documents	27%	21%	10%	10%
Easier to validate findings with NASA documents***	19	25	8	11
Better job of providing alternative methods with NASA documents	21	13	19	11
Better job of helping to cut costs with NASA documents***	15	12	11	10
Information from NASA is superior	26	13	19	13

*From Executive Questionnaire, items #21 - 25. Of the 144 executives in the study, 90 reported personal experience with NACA. This table is based on these 90 responses.

**To simplify the presentation in the above table, the percentages for the agree nor disagree are not included. These percentages for each item are: 1. (Easier to apply), 32%, 2. 37%, 3. 36%, 4. 52%, 5. 29%.

***To control for response order bias, the wording of these two items in the questionnaire is opposite of that presented here (see items 22 and 24). For consistency of presentation with the other three items (#21, 23, and 25), the wording and data have been reversed in this table. The table may be read correctly as presented without any loss of information or alteration and interpretation.

The second question asked whether it was easier to validate findings with NASA documents than with NACA documents. (In order to control for response order bias, the wording of questions 2 and 4 were opposite of the wording presented here. The wording of the questions - and the data - have been reversed in this discussion for consistency of presentation; this modification has no effect on the findings.) Nineteen percent strongly agreed and 25% mildly agreed (44% agreed to some extent) that it is easier to validate findings with NASA documents; only 19% strongly or mildly disagreed.

Executives were asked whether they thought NASA documents did a better job of providing alternative methods than NACA documents. The responses to this question were more evenly divided than were those to the previous two questions: 34% agreed with this statement and 30% disagreed.

When asked whether NASA documents did a better job of helping to cut costs, a total of 27% of the executives agreed and 21% disagreed. Finally, when asked whether they thought NASA information was superior to that provided by NACA, a large number of executives (39%) agreed (26% strongly and 13% mildly) that NASA information was superior. A surprisingly large 31%, however, also disagreed: 19% mildly and 13% strongly.

In summary, the data reported in Table 29 seem to indicate the following:

1. Executives feel most strongly that the information provided by NASA is easier to apply.

2. Executives hold rather strong but divided feelings about whether information from NASA is better than that provided by NACA. Slightly more than a third think NASA is superior, slightly less than a third think that NACA was superior.

3. Executives have divided opinions about whether NASA does a better job of helping to cut costs. A little more than a quarter indicated that they thought NASA was better; a little less than a quarter thought NACA was better.

4. Executives, in a ratio of more than two-to-one (44% to 19%), felt that it is easier to validate findings with NASA documents.

5. Executives were rather strongly divided on whether NASA documents do a better job of providing alternative methods. Just over a third said NASA was better; just under a third said NACA was better.

While the results in Table 29 generally indicate that executives view NASA more favorably than they do NACA, the data also show a fairly large percentage who view NACA as superior in some aspects. The personal interviews with the executives provide some additional insight and some explanations for these findings.

A number of executives were quite explicit in the ways they thought NACA publications were superior to those produced by NASA from the standpoint of the aircraft industry. The NACA publications, they say, were more basic research, provided more definitive statements, and provided more comprehensive data. Rather than small studies covering a specific specialized area or problem, the studies and reports were more comprehensive and exhaustive, and as such have become known as classics in the field; the data were almost always provided in the reports. Even extensive tutorials were sometimes published so that industry personnel could learn new methods and ways of conducting research, rather than just the results of those new methods. As one executive, who was also a chief engineer, noted, NACA used a lot of what might be called a "cookbook approach," providing the data so that the engineers could replicate the findings for themselves. That situation rarely exists in current NASA reports.

A scenario was sketched by a number of executives which may help to put some of these responses into perspective. Prior to this country's venture into the space program, NACA was the undisputed leader in the aeronautical industry. It did much of the basic research on engines, airfoils, helicopters, and on many of the basic aeronautical concepts, and provided this information to the aircraft industry which at that time was too small to do very much of its own basic research. The companies themselves then did much of the applied research.

NACA's efforts were narrowly focused on aeronautical problems, and this narrowness of purpose led to high quality, in-depth research on basic topics. When NASA was formed as a replacement for NACA and pursued this country's objectives of space exploration, it was necessary for NASA to undertake a much broader area of research with a much more pragmatic and applied orientation. During this period of major space orientation, NASA largely neglected research in the area of aeronautics; as a result, the larger aircraft companies developed their own research programs and began to fill the gap which NASA had left. With the recent reorientation of NASA to develop a better balanced program in aeronautics and astronautics, NASA has begun to reestablish the excellent program of aeronautical research that existed during the days of NACA.

The following are some of the comments by executives about what they see NASA's role should be today:

> "NASA should be doing basic research and developing advanced technology. However, NASA likes to do, for political and image reasons, what industry should be doing and, to a large extent, does it best."

> "NASA should be conducting fundamental research pointing to new concepts, concentrating less on hardware and more on new concepts."

> "NASA should be the leader in developing technology, a common base for all companies in the aerospace industry, recognizing what research and development is needed and contracting for it, and then making information results available in the common literature."

> "In the data it provided, NACA was more precise, meticulous, and thorough in following through the calculations. NASA today comes across more sloppy, more "black box," which is a fact that leads to reduction in its credibility. Even computer programs often have unknown errors, thus aggravating the problem."

"Unlike NACA, NASA does not translate information for designers into their terms and with the kinds of conclusions which are needed. NASA publications are not written for company technologists."

Accuracy of Industry Executives' Views of Their Employees' Relationship with NASA

Industry executives often are in a position where they must speak for the industry, or at least their own company's role in it. While granting both the right and the responsibility of executives to represent their own views, as well as present the official positions of their companies, it is still appropriate to raise the question of the degree to which executives (or anyone else) are accurate when they represent the views of their employees.

To provide data on this important topic, executives were asked to predict how they thought the researchers, designers, engineers, and scientists in their company would respond to a set of questions contained in the Researcher/Designer Questionnaire. A comparison between these predictions and the researchers' actual responses provides a measure of accuracy which is the focus of this section. The data for the original responses given both by researchers and executives have already been presented and discussed earlier in this report. In this section, we examine the ability of the executives to correctly predict the views of their employees.

Data are reported in Table 30. Column A provides data (already discussed elsewhere) about the executives' response to the questions, and is provided for comparative purposes only. Column B provides the executives' predictions of the responses given by a typical researcher. Column C provides the actual responses provided by the researchers in this study (these data have also been previously discussed in this report). The final column,

Table 30. Accuracy Measures Between Executives' Predictions About Typical Researchers and Their Actual Responses*

Variable	A** Executive Responses	B Executive Prediction of Typical Researcher	C Researcher Responses	D*** Accuracy
Use face-to-face communication with NASA	16 times/year	11 times/year	8 times/year	+3
Importance of face-to-face communication	4.5****	4.6	4.2	+.4
Use of telephone to call NASA	22 times/year	17 times/year	19 times/year	-2
Importance of telephone	4.3	4.6	4.4	+.2
Use of letters to communicate with NASA	10 times/year	17 times/year	19 times/year	-2
Importance of letters	3.7	3.8	3.5	+.3
Use of library	(question not asked)	39 times/year	41 times/year	-2
Importance of library		5.7	5.3	+.4
Use of NASA documents	27 times/year	29 times/year	32 times/year	-3
Importance of using NASA documents	4.4	5.2	4.9	+.3
Reads NASA articles	(question not asked)	19 times/year	17 times/year	+2
Importance of NASA articles		4.5	4.2	+.3
Receive NASA documents in beginning of project	(question not asked)	25%	28%	-3%

Table 30. (Continued)

Variable	A Executive Responses	B Executive Prediction of Typical Researcher	C Researcher Responses	D Accuracy
Receive NASA documents in middle of project	(question not asked)	63%	55%	+8%
Receive NASA documents too late	(question not asked)	8%	10%	-2%
Effort to obtain NASA documents	(question not asked)	2.7	2.2	+.5

*See Executive Questionnaire, items #11 through 20.

**Executive self-report data are provided here for comparative purposes; they have been discussed in detail elsewhere in this report.

***Accuracy is the difference between columns B and C, i.e., between the executives' prediction of researchers and the researchers' data. Zero indicates complete accuracy. The larger the absolute value of the number (ignoring positive or negative) the less the accuracy (the greater the inaccuracy). A positive number indicates that the executives over-estimated the researchers' responses; a negative number indicates an under-estimate.

****Data on importance items are mean responses to a seven point scale ranging from "1" for "very unimportant" to "7" for "very important."

D, provides the accuracy data and is determined by taking the difference of Column B minus Column C. The closer the numbers in Column D are to zero, the more the executives' predictions are like the actual responses of the researchers and consequently, the higher is the executives' accuracy. The larger the absolute value of the number (either positive or negative), the poorer the accuracy. Positive numbers indicate that the executives over-estimated the researchers' response; negative numbers indicate that the executives under-estimated.

There are two very interesting results revealed in this table. First, an examination of Column D indicates that the executives are quite accurate in their predictions of the responses of their employees. The largest inaccuracy was in predicting the effort necessary to obtain NASA documents: on a seven point scale, executives over-estimated the difficulty by half a scale point, +.5. The largest inaccuracy in assessing the frequency of their employees' communication with NASA was a +3 times per year over-estimate of the frequency of their employees' face-to-face communication with NASA (executives predicted 11 times per year for the researchers). They also see a real difference in the importance of the use of NASA documents to their employees, though they over-estimate this difference a little bit. Frequency of communicating with NASA via letter is another difference between themselves and their employees that they correctly perceive.

In the personal interviews, executives indicated one major difference between their own technical information needs and those of their researchers. While this varies somewhat with theoretical interests and mathematical emphases, almost all executives indicated that they look for broad ideas, overviews of research projects, summaries of major research findings, and basic issues. Their employees on the other hand are much more concerned with the procedures for research, the details of the data, refinements in analytic techniques, and all the other specific factors which are necessary to carry out the research and/or design program. Irrespective of their opinions about the way NASA was serving the information needs of their employees, most executives felt quite strongly that NASA technical information did not provide them with the good abstracts, adequate summaries, good think pieces, and provocative perspective papers that they needed and wanted.

In general, the data in Table 30 show the executives to be highly accurate in their perceptions of their employees' responses. They also see several distinctions between themselves and their employees, distinctions which appear to exist in fact. While we would not be willing to extrapolate the findings of these data beyond the set of questions over which they were asked, nor to any general characteristic of executives, they do speak well for the degree to which executives in the aeronautics industry appear to be in touch with those they manage.

Conclusions

This section reported assessments of NASA publications from a variety of perspectives: obtaining publications, using publications, communicating with NASA, comparisons of NASA with NACA, and accuracy of executives' views of their employees' relationships with NASA. Because of the number of topics in this section and their complexity, major conclusions have been stated throughout the text. The following are some overall conclusions.

Obtaining NASA Publications

The company library is a very important link in the process of disseminating NASA technical information. Less than intermediaries, most company librarians appear to function effectively as facilitators. Most company libraries are considered by executives and researchers as valuable resources which function efficiently. Where problems occur, they appear to be in the policies and procedures which occur between completion of a publication and its receipt at a company. Some of these problems appear to include: (1) which publications are chosen for indexing in STAR, made available on automatic distribution, and made available in hardbound copies, (2) the adequacy of instructions for ordering NASA publications through STIF, (3) the effectiveness of invoicing and shipping documents, and (4) the amount of time required to produce and distribute NASA publications.

Assessments of NASA Publications

While all NASA publications may not have the same level of readership, about 76% of the aeronautical documents in the study had been read and 80% of those had been read from half to completely. There are indications that NASA aeronautical publications are somewhat lacking in meeting basic information needs of researchers, particularly in the areas of aircraft design, basic aircraft research, instrumentation, stability, and propulsion. The most important aspect of the articles they evaluated were seen by researchers to be maintaining professional awareness. Apparent unimportant aspects of NASA publications are seen as helping to save money or saving time. Some areas where NASA publications perhaps should do a better job, from the viewpoint of company users, include providing new ideas, validating company research, preventing duplication of work, improving the quality of work, applying ideas, and suggesting alternative methods. Several of these also were identified as NASA inadequacies, as reported in a subsequent section of this chapter.

Industry Communication with NASA

Face-to-face and telephone communication between company and NASA personnel are considered to be very important by executives and researchers, the telephone often used for quick information or preliminary information-seeking and face-to-face communication used when a situation indicates the need for greater depth of information. Personal interviews indicated that the outcomes of these communication interactions generally are considered to be most satisfactory.

Executive Comparisons of NASA and NACA

Overall, executives believe it is somewhat easier for their employees to apply the information from NASA than it was from NACA, although one of the issues identified by researchers (see section on Major Issues) is the lack of applicability of NASA publications. This suggests that NASA publications are easier to apply than were those of NACA but still not up to the expectations of direct users. Executives also indicated they believe it is easier to validate findings with NASA publications than with those of NACA, but again researchers, as reported in a subsequent section, raise this as somewhat of an inadequacy of NASA today.

Areas which should be of some concern to NASA include the fact that executives hold strong but divided feelings about whether information from NASA is better than that provided by NACA, as is the case with whether NASA documents do a better job of helping to cut costs and provide adequate alternate methods. In personal interviews, industry leadership of NACA was often cited as an area where NASA does not compare as favorably, as well as in the types of basic research conducted by NACA which is not carried on by NASA.

Accuracy of Executives' Views of Their Employees' Relationship with NASA

One of the questions addressed was the accuracy of executives in speaking for the industry or their company in actually reflecting the viewpoints of the direct users of NASA technical information: company researchers and designers, or scientists and technologists. In almost all areas, executives do appear to be reflecting the viewpoints and evaluations of NASA of their employees. In personal interviews, executives did identify one major difference between their own technical information needs and those of their researchers. Almost all executives look for broad ideas, overviews of research projects, summaries of major research findings, and basic issues. Researchers, on the other hand, are much more concerned with the procedures for research, the details of the data, refinements in analytic techniques, and all other specific factors which are necessary to carry out the research and/or design project. This suggests the possible need for different methods of communicating with executives and researchers.

MAJOR ISSUES IDENTIFIED BY EXECUTIVES AND RESEARCHERS

Introduction

In the mail questionnaire, executives and researchers were asked for open-ended responses in four general areas: (1) benefits of receiving NASA technical information, (2) information needs of the company in areas where NASA does research, (3) inadequacies of NASA technical information and publications, and (4) recommended changes.

The four specific questions were: (1) "What do you consider to be the three major benefits of receiving NASA technical documents?", (2) "Within the areas in which NASA does research that is relevant to your company, what are your three most important information needs?", (3) "What do you consider to be the three major inadequacies?", and (4) "What changes in NASA documents would make them more useful to your organization?" (See Executive Questionnaire, items #29, 30, 31, and 33 and Researcher/Designer Questionnaire, items #21, 22, 23, and 24.)

In response to these four questions, a total of 2,680 suggestions were received, 892 from executives and 1,788 from researchers. Nearly 80% of the executives and researchers provided comments on these questions. In this section, the tables represent the data obtained from these four open-ended questions.

The questionnaire also had what, in effect, was a fifth open-ended question related to the four areas noted above: "Please provide any additional comments or suggestions that you might have about NASA technical documents." In most cases, responses received either emphasized or elaborated upon a suggestion previously made. Some of these comments are used in this section where they clarify an issue or suggestion.

Also reported in this section is information received in the series of 30 in-depth personal interviews at six different companies in the aerospace industry. The bulk of these interviews was with executives, primarily in the engineering and research and development divisions of their companies. Their areas of specialization included aerospace design, materials, mechanics and dynamics, systems engineering, structural analysis, aerothermal, and others. Also included in the group were five chief or senior engineers. In all interviews, both the executives and their staff members were familiar with and frequently used NASA publications in their work.

In the sections that follow, the first series of tables summarize all 2,680 responses in each of the general categories: needs, benefits, inadequacies, and changes. The remaining tables examine the 2,680 comments by general issues, of which five primary issues were identified: (1) Content, (2) Presentation of Information, (3) Writing Style, (4) Format and Design, and (5) Distribution or Dissemination.

Within each of these divisions there are many issues, some closely related to each other or providing possibly important distinctions. In tables and text, issues in each of these five divisions are examined in relation to each other and in regard to the overall categories of need, benefit, inadequacy, and change. There also were some issues which either did not fit neatly into one of the five divisions or appeared important enough to examine them separately. Most of these issues had to do with content.

Data from the open-ended questionnaires are reported in the tables; additional information from the personal interviews and comments written as part of a final, very general open-ended question are included in the text.

Summary of Responses by Category: Needs, Benefits, Inadequacies, and Changes

Table 31 indicates the percent of the 2,680 responses and the rank order by general category: (1) needs, (2) benefits, (3) inadequacies, and

(4) changes. The rank order is indicated at the left, followed by a number in parenthesis which indicates the order in which the questions were actually asked on the questionnaire. Both the percent of suggestions in each category and the actual number of suggestions are indicated by executives and researchers.

Table 31. Percent of 2,680 Responses and Rank Order by Response Category for Executives and Researchers on Four Open-Ended Questions

Rank Order	Order Asked	Category of Responses	Executives No.	Executives %	Researchers No.	Researchers %
1	(2)	Technical Information Needs	308	35	704	39
2	(4)	Benefits of NASA Information	247	28	516	29
3	(3)	Inadequacies of NASA Information	173	19	316	18
4	(1)	Recommended Changes in NASA Technical Information	164	18	252	14
			892	100%	1,788	100%
		TOTAL		2,680		

Executives (35%) and researchers (39%) are about equal in the area in which they placed greatest attention: technical information <u>needs</u> in areas in which NASA does research. Both groups also placed emphasis similar to each other on the other three categories: benefits, 28% and 29%; inadequacies, 19% and 18%; and changes, 18% and 14%.

For both executives and researchers, the benefits of receiving NASA technical information outweigh the inadequacies of NASA publications by a ratio of 3:2 (for every two inadequacies cited, there are three benefits identified). At the same time, the technical information needs of companies in areas in which NASA does work are greater than the benefits of receiving

NASA publications by a ratio of 3:2 (for every two benefits mentioned, three unmet needs are identified). This suggests that there are areas of need which it is believed NASA should be meeting and either is not meeting or is meeting less than effectively. That the former may be the case -- NASA is not meeting all the needs which executives and researchers believe it is NASA's role to meet -- is suggested by the fact that needs substantially outweigh (7:3) inadequacies. In other words, while there are some existing inadequacies in the information now provided by NASA, there may be some needs which are going totally unmet and which company personnel believe that NASA, and not another organization, should be meeting. Some of their technical information needs, executives and researchers realistically realize, may never be able to be met by NASA, but there appear to be specific NASA inadequacies that could be corrected by various changes.

General Issues Identified: Content and Presentation, Writing Style, Format, and Distribution

The 2,680 responses to the four open-ended questions on needs, benefits, inadequacies, and changes were classified into five general issue areas: (1) content (i.e., both general or broad topics such as "trends" and specific topics such as "advanced composites"), (2) presentation (i.e., organization, relevancy, repetition, etc.), (3) writing style (i.e., scientific, tutorial, etc.), (4) format and design (i.e., hardbound, graphs and tables, etc.), and (5) distribution or dissemination (i.e., timeliness, awareness of new titles, etc.). Two other related issues, primary sources of technical information and actual patterns of use of NASA publications, have been covered in earlier sections of this chapter. Within each of the five general issue categories, responses have been further subdivided into more specific issue areas (i.e., organization, relevancy, tutorial style, timeliness, etc.)

The process of organizing 2,680 suggestions into five general issue subdivisions and narrower issues within each provides the general organizational scheme for this section on issues. The process used to organize the 2,680 responses, though not perfect, provides reasonably fine distinctions between issues. While fewer categories would have been possible, this would have had the disadvantage of blurring distinctions which may be important. At the same time, it is recognized that there is some overlap between the general and specific issue subdivisions which have been created. This chapter is organized and data are reported in accordance with this category scheme.

The following four tables (32 through 35) summarize the percentage of s in major issue subdivisions within the four categories: benefits, inadequacies, and changes. Data are reported separately for executives and researchers.

Information Needs

By far the greatest information need (Table 32) of executives and researchers is for technical information on specific topics (i.e., materials, aerodynamics, aircraft and flight control and stability, etc.). Researchers (64%) seek this specific information even more than executives (54%). In personal interviews, executives reported that one of their functions as department managers is to keep abreast of new developments. Thus, they tend to scan lists of new publications to identify those which might be of value to their staff members. As one manager noted, "I try to review STAR, MIT, SCAN, and other abstract publications about once a week to spot key articles of use to my department." This appears to be a common pattern for most executives interviewed.

Table 32. Summary of Needs: Major Technical Information Needs*

Needs**	Executives	Researchers
Content:		
Specific Subjects	54%	64%
General	21	16
Presentation	18	17
Dissemination	5	2
Format and Design	2	1

*Based on 1,012 responses; 308 from executives and 704 from researchers.
**See Tables 36, 37, 42, 48 and 51 for additional data on needs.

There are occasions, however, when executives thoroughly read publications. This appears to occur at two points: (1) when a new project is starting, which enables the executive to acquire a data base for providing design or other guidance to staff members, and (2) when a technical application requires a management decision. Another reason executives offered for scanning or reading NASA and other technical publications is to avoid duplication of work. General topics (i.e., methodology, design concepts, etc.) and procedural content (methods of analysis reported, completeness of data, relevancy, accuracy, etc.) are about equal in importance for executives (21% and 18%) as well as for researchers (16% and 17%).

Benefits of NASA Information

In terms of benefits (Table 33), there is general agreement between executives and researchers that a combination of broad content matters make

NASA technical information useful, along with two very specific areas: (1) assistance with planning and problem-solving and (2) assistance in working with NASA. Executives (42%) are somewhat more concerned than are researchers (31%) about the usefulness of NASA publications in planning and problem-solving, along with usefulness in providing direction in working with NASA. Researchers (69%) place somewhat more emphasis than do executives (57%) on specific topics and general content issues.

Table 33. Summary of Benefits: Major Benefits of Receiving NASA Techncial Information*

Benefits**	Executives	Researchers
Dissemination, Writing, Presentation, and General Content	57%	69%
Assistance with Planning and Problem-solving	23	18
Assistance in Working with NASA	19	13

*Based on a total of 763 responses; 247 from executives and 516 from researchers.
**See Tables 40, 41, and 43 for additional data on benefits.

Inadequacies of NASA Information

There is great similarity between executives and researchers in their opinions about inadequacies (Table 34) of NASA technical information and publications. Of great concern (36% and 37%) are procedural matters: how information is presented within reports (i.e., sufficient data, applicability, narrowness, etc.). An almost equal area of concern (34% and 34%) is the adequacy of current dissemination methods, both from NASA to companies and within companies.

Table 34. Summary of Inadequacies: Major Inadequacies of NASA Technical Information*

Inadequacies**	Executives	Researchers
Presentation	36%	37%
Dissemination	34	34
Content	17	15
Format and Design	8	9
Writing Style	5	5

*Based on 489 responses; 173 from executives and 316 from researchers.
**See Tables 38, 44, 46, 49, and 52 for additional data on inadequacy issues.

Changes Recommended by Executives and Researchers

Of the changes (Table 35) executives and researchers would make regarding NASA technical information and publications, both groups are nearly identical in their areas of concern: (1) dissemination methods (37% and 40%) and (2) how information is presented within publications (35% and 36%). Executives (14%) have greater concerns about general content than do researchers (7%); as previously noted, researcher comments were most extensive regarding narrow topics.

In summary, there are few major differences between executives and researchers both in the benefits they see in receiving NASA technical information and in the problems or issues they have identified. Where differences do occur, they are fairly predictable, considering some basic differences in the functions of executives or managers and researchers and designers.

Major findings and conclusions in each of the issue areas will be covered in the following portions of this section.

Table 35. Summary of Changes: Recommendations for Major Changes in NASA Technical Information*

Changes**	Executives	Researchers
Dissemination	37%	40%
Presentation	35	36
Content (General)	14	7
Format and Design	9	11
No Changes	4	2
Writing Style	1	3

*Based on 416 responses, 164 from executives and 252 from researchers.
**See Tables 39, 45, 47, 50, and 53 for additional data on change issues.

Major Issues

As indicated in Table 32, of the five general subdivisions of issues, that which received the greatest number of comments by executives and researchers is related to specific content, or topics. This issue may be further subdivided into two parts: narrow topics and general topics. Within each of these two groups there are a number of individual issues. In addition, two specialized general topics were identified: (1) planning and problem-solving and (2) working with NASA. As previously noted, between all general issue subdivisions there are obvious overlaps.

Content: Narrow Topics

Needs. While researchers (64%) place slightly greater emphasis on the importance of specific narrow topics than do executives (54%), both rank this as their primary area of information need. There were 172 responses from executives and 451 from researchers. In total, the two groups identified more than 80 difference narrow topics of information need in their work, responding to the question "Within areas in which NASA does research that is relevant to your company, what are your three most important information needs?" This relatively large number appears to reflect the diversity of areas of specialty represented in the sample.

Table 36. Content of Narrow Topics: Major Technical Information Needs*

Subject	Executives	Researchers
Materials (including fracture and fatigue)	12%	10%
Aerodynamics	9	9
Aircraft & Flight Control & Stablity	8	8
Computer Technology, Developments, Methods	8	5
Space Flight and Shuttles	8	5
Structures	7	5
Propulsion	6	6
Engines and Turbines	4	5
Fluid Mechanics	3	5
Instrumentation	3	3
Flight Tests & Simulations (including wind tunnel tests)	2	4
Heat, High Temperature Analyses	2	3
Composites	2	2
Electronics	2	2
Energy	1	2
Others (all 1%): Astronautics, Aeronautics, Navigation, Environment, Equipment, Helicopters, Medicine, Noise, Physics, Systems, V/STOL, and Sensors	23	12
Other Topics (less than 1%)	6	11

*Based on 623 responses; 172 from executives and 451 from researchers.

Table 36 (above) identifies the major topics. Once these were identified as a basic information need in one question, they were not referenced again in response to other open-ended questions except for materials, helicopters, and V/STOL, which were identified by a small number of respondents as an inadequacy. As one researcher interviewed noted, "The problem is less that of quantity or scope of NASA publications but one of discrimination."

Content: General Topics

Needs. Table 37 shows some of the more general content needs of executives and researchers. Some of these topics appear to take on greater significance because they also reappear as inadequacies or recommended changes, shown on subsequent tables.

Table 37. Content of Broad Topics: Major Technical Information Needs*

Subject	Executives	Researchers
Methodology	20%	19%
Design Data	18	21
Parametric Data and Measurement	13	13
Trends, Research, and Development Needs	10	11
Configuration Identification by Manufacturer, Model, etc.	8	4
Planning Dates and Schedules	8	4
Cost Data and Effectiveness Data	8	4
Operational Performance	7	16
Computer Decks and User Manuals with Programs	5	2
Technical Forecasting	3	2
Standards	0	2
Testing Data	0	1

*Based on 177 responses; 61 from executives and 116 from researchers.

Both executives and researchers place high priority on obtaining specific data from NASA publications: methodology, design, operational, and many other types of data. This also is an area where NASA publications are moderately to strongly criticized as being inadequate (see Table 44). One manager in the personal interviews observed that much of the data contained in most NASA publications generally is adequate for both executives and researchers from the standpoint of keeping generally abreast of new developments. The lack of data becomes apparent when NASA publications are used in connection with specific research or development activities. "It is likely," one chief engineer explained, "that engineers don't always need all the data they think they need; on the other hand, some NASA publications fall short of basic needs, particularly to enable comparisons of NASA results with those obtained in our own work."

Other general content information needs which do not rank high on the table above but which receive further attention as an inadequacy or recommended change and in comments in the personal interviews are: parametric and other measurement data, identification of configurations, and computer decks and user manuals for NASA computer programs.

Inadequacies. Table 38 indicates the general content inadequacies noted by executives and researchers.

Nearly half of both executives and researchers reported that the major inadequacy of NASA publications is a failure to relate current research to other on-going projects or research which has occurred previously. Another way of expressing this was the need for publications to report the state-of-the-art. In personal interviews, executives often noted that the state-of-the-art publications of NACA were one of its great strengths; it is one of the major features missing and needed from NASA today. Many of these NACA publications are considered "classics," and several executives urged that

NASA publish about once a year state-of-the-art publications in various areas of specialization.

Table 38. General Content: Major Inadequacies of NASA Technical Information*

Inadequacy	Executives	Researchers
State-of-the-Art, Theory, Relationship to Past and Other Efforts Inadequate	48%	46%
Not Enough Basic Research	24	13
Some Subjects Over-published	7	4
Mathematical and/or Engineering Emphasis Weak	7	2
Too Little Materials, Helicopter, Double Lattice Method, Aeroelastic, Etc., Work	7	0
Inadequate Configuration Data	3	23
Costs, Schedules, Etc. not Reported	3	8
Computer Codes Have "Bugs"	3	0
Not Design Oriented	0	2

*Based on 77 responses; 29 from executives and 48 from researchers.

Of particular concern to researchers (23%) is the lack of configuration data in NASA publications. Suggestions were received both on the open-ended questions and in the personal interviews that NASA identify configurations by manufacturer, model, and in other ways. One executive noted a further advantage in identifying models even in the titles of publications. If an article is about one model airplane, for example, the identification of it by model in the headline will tell researchers whether or not the article is of immediate interest to them. An issue of particular concern to executives (24%) is that of "basic research," covered in earlier sections of this report.

Table 39 indicates content changes in emphasis or additional topics which are recommended.

Table 39. General Content: Recommended Major Changes in NASA Technical Information*

Change	Executives	Researchers
Greater Configuration Coverage	33%	22%
Increase Publications on State-of-the-Art, Theory, Relation of One Project to Others	22	22
More NASA In-House Research	22	0
Increase Coverage of Specific Subjects, Including: Materials, Structural Mechanics, Etc.	10	11
Emphasize Trends, Plans, Needs, and R & D Potentials	9	28
Less Parametric Data	4	5

*Based on 41 responses; 23 from executives and 18 from researchers.

Changes. Executives (33%) somewhat more than researchers (22%) placed highest priority on more configuration data. Both groups are about equal in emphasizing the need for more state-of-the-art publications, relationship of research projects to basic theory, and relationship of new projects to those of the past or other on-going projects. This latter point was particularly emphasized in the personal interviews. A number of executives observed that perhaps only the Air Force has made any concerted effort to attempt to correlate, synthesize, and relate existing information. One executive suggested that if NASA is not able to do this critically needed job, it should be contracted out. Another executive observed that there might exist 150 different reports on 150 different wind tunnel tests, with no attempt to correlate data or summarize basic findings.

Researchers (28%) also place emphasis on the need for more information about trends, plans, needs, and research and development potentials. Executives (22%) emphasize the desirability of more NASA in-house research. In personal interviews there was general concensus that reports prepared by NASA generally are of a "higher quality" than those from subcontractors. Several executives suggested that NASA develop standards for publications produced by outside contractors to improve consistency.

While there is a small but vocal group which would like to see less parametric data (5%), a much larger number, indicated on other tables (see Table 44), wish to see greater use of parametric data. One chief engineer suggested that NASA move entirely to the metric system and provide conversion tables along with the metric data reported.

Content: Planning and Problem-Solving

Benefits. One of the specialized benefits of receiving NASA technical information is that it assists particularly with the problem-solving functions in companies, as Table 40 indicates.

Table 40. Assistance with Planning and Problem-Solving: Major Benefits of Receiving NASA Technical Information*

Benefit	Executives	Researchers
Data Helps with Problem-Solving	26%	38%
Data Helps with Planning	19	20
Data Provides Names Useful for Consultation	19	9
Data Generates New Ideas	16	14
Data Reduces Costs	16	12
Data Identifies Problems	3	3
Data Helps with Follow-Through	2	3

*Based on 149 responses; 58 from executives and 91 for researchers.

Researchers (38%) place somewhat greater emphasis on the problem-solving benefits than do executives (26%). Substantially lower in rank (3%) is the ability of NASA information to help identify specific problems or needs, although the ability of NASA publications to generate new ideas has moderate recognition (16% and 14%). As one manager noted, "I would like to see more speculation in technical reports on the potentials of a specific bit of work: the kind of reporting that is idea provoking." The criticism that NASA publications rarely draw conclusions may be related to this concept of generating new ideas. NASA publications also have some recognition for their ability to assist with planning. Most executives interviewed, in fact, cite the planning function as one of the critical times when they personally are apt to refer to NASA publications. Also related to the planning and problem-solving functions is usefulness, especially to executives, of NASA publications in providing names of individuals who can be contacted for consultation when a problem arises which cannot be solved within the company.

Needs. When problems or information needs arise in connection with a project, however, few of the executives turn first to NASA. The sequence usually is to turn first to others within the company and then to the company library, which often will do a literature search either within library materials or outside the company. If the literature search does not meet the need, both executives and researchers are likely to turn to personal contacts outside the company. Sometimes the organization contacted is NASA, although other organizations are cited as external sources as frequently as NASA and all other sources in total rank higher than NASA. These outside sources include branches of the military service, other companies in the industry, research companies, consultants, British and French organizations, and universities.

When asked the five leading sources of technical information in rank order which they need and use, executives interviewed in person generally ranked NASA third or fourth in importance. The first source in most cases is internal resources, both the library and staff members. Branches of the military service usually rank second, particularly the Air Force, Navy, and Army, as well as the Department of Defense. The third most used source tends to be a mixture of research firms; association publications, especially AIAA; other firms in the industry; and other types of organizations. NASA often is one of these third ranked sources or sometimes listed as the fourth source contacted. The fifth most-used source is a mixture of universities, consultants, international firms, and, if not used in the literature search, AGARD, NTIS, journals, and other services and publications.

Because of the need to go outside the company for problem-solving assistance, all executives interviewed reinforced the need, previously covered his report, of having personal contacts. While potential contacts are ined from reading NASA and other publications, seminars and symposia also are often cited as important sources for establishing contacts outside the company.

Content: Assistance in Working with NASA

Benefits. Another specialized benefit in receiving NASA publications, as Table 41 indicates, is their ability to help executives and researchers in working more effectively with NASA. Of greatest importance is the insight publications appear to provide in both the overall direction of NASA at any point in time and the requirements of NASA (55% and 57%). Much more so than researchers (12%), 30% of the executives also see a value in NASA publications in that they help prevent duplications of research or other work that is being done by NASA or other organizations. The desirability of preventing duplication also may be one of the benefits, some of the personal interviews indicated, of NASA publication of work-in-progress or interim reports.

Table 41. Assistance in Working with NASA: Major Benefits of Receiving NASA Technical Information*

Benefits	Executives	Researchers
Provides Direction and Requirements of NASA	55%	57%
Prevents Duplication with Other NASA Efforts	30	12
Identifies Trends	11	27
Other	4	4

*Based on 114 responses; 47 from executives and 67 from researchers.

Presentation of Information

Needs. The manner in which information is presented is closely related in some areas to the general topic section just covered and the writing style and format and design sections to follow. Table 42 indicates needs in this area.

In the presentation of data in reports, the desirability of relating current work to past efforts again figures high as a priority of both executives (30%) and researchers (24%). A related notion is that of periodically issuing publications on the state-of-the-art.

Executives slightly more than researchers cite a second basic need for good analyses and correlations between experiments and analyses, closely followed by the importance of complete data on costs, tests, correlations, performance, and other factors.

Table 42. Presentation: Major Technical Information Needs*

Need	Executives	Researchers
Relationship of Current Work to Past Efforts: Comparison to State-of-the-Art	30%	24%
Good Analyses and Correlations Between Experiments and Analyses	23	17
Complete Data on Costs, Tests, Correlations, Performance, etc.	14	14
Relevancy and Applicability	12	11
Experiment and Test Verifications	9	12
Breadth (Large Scope vs. Narrow)	6	5
Good Abstracts/Summaries/Introductions	5	6
Accuracy	2	7
Complete References/Non-NASA References	2	3
Definitive Conclusions	2	1

*Based on 178 responses; 57 from executives and 121 from researchers.

Table 43. Presentation: Major Benefits of Receiving NASA Technical Information*

Benefit	Executives	Researchers
Technical Information is Up-to-Date	31%	31%
Provides a Useful Data Base	27	26
Data is Reliable, Valid, and Accurate	20	12
Provides Technical Information in Areas of Current Interest	14	15
Data is Objective	6	3
Data is Well-Written, Organized, and Thorough	2	6
Data is Received in a Timely Nature	1	3
Data is Easy to Obtain	0	4

*Based on 500 responses; 142 from executives and 358 from researchers.

Benefits. Table 43 (above) shows some of the major benefits of existing NASA publications which include: up-to-date technical information and reliable, valid information. Two important related benefits are that NASA publications provide a useful data base and information in areas of current interest.

Inadequacies. Table 44 covers inadequacies in procedural type content; some of the inadequacies have appeared before on other tables as needs or as related inadequacies.

Table 44. Presentation: Major Inadequacies of NASA Technical Information*

Inadequacy	Executives	Researchers
Data Insufficient (including parametric data)	28%	17%
Not Relevant to Current Needs	18	9
Not Applicable (also see "Relevancy")	17	15
Too Narrow	12	12
Too Shallow or Generalized	8	10
Analysis Inadequate	6	10
Not Objective; Only Presents NASA Point-of-View	5	9
Does not Reference Non-NASA Scientists or Sources	2	6
Conclusions are Weak	2	6
Abstracts, Definitions, etc. are Weak	2	3
Inconsistencies Occur Within Reports	2	0

*Based on 184 responses; 65 from executives and 118 from researchers.

A major inadequacy is insufficient data, although this is of greater concern to executives (28%) than to researchers (17%). This appears to be inconsistent with other data previously reported; large numbers of researchers, however, reported this concern in other ways. Both executives and researchers

(17% and 15%) have similar concerns about the applicability of NASA publications, a concept closely related to relevancy which is the second ranked inadequacy noted by executives.

The importance of several of the issues already reported is emphasized in Table 45, all issues of which generally relate to the development of technical publications.

Table 45. Presentation: Recommended Major Changes in NASA Technical Information*

Change	Executives	Researchers
More Relevancy, Applicability	28%	19%
Better Analysis of Results, Test Verifications, and Correlations	25	24
Better Abstracts, Summaries, or Introductions	12	18
More Thorough Reporting; More Complete Data	11	10
Better Conclusions	7	8
Broader Scope (also see "Narrower")	5	6
Greater Scope in References Used; More Non-NASA	5	4
Narrower Scope	5	3
Relate Data to Earlier Studies	3	4
Better Definitions	1	2
More and Better Cost Data	1	1
More Accurate	0	1

*Based on 147 responses; 57 from executives and 90 from researchers.

<u>Changes</u>. There is agreement between executives (25%) and researchers (24%) that NASA should provide better analyses of results, test verifications, and correlations of data. In personal interviews the issue of sufficient data was explored in greater depth and frequently was related by executives

to the adequacy of conclusions. It was pointed out that few NASA reports draw conclusions. While many executives did not agree with this practice, they noted that it was "understandable." However, because the reports do not draw conclusions, the need for sufficient data increases. The data are needed by researchers in order to critically evaluate the apparent outcomes.

A number of other issues previously identified appear in this table; some of which seem to have greater significance than the actual figures in the table suggest, primarily because these issues were stated over and over in various ways. These issues are: better abstracts, summaries, or introductions (see dissemination issues); relationship of data to earlier studies; greater scope in the number of non-NASA references used; and more data, sometimes referred to as "point data" by researchers.

Writing Style

Inadequacies. Executives, much more than researchers (32%), are critical of the often very formal, tutorial writing style of NASA publications, although one executive interviewed noted that "too often when the writing style is good, the data is lacking" (see Table 46). Executives also find NASA publications more repetitious than do researchers. Of greatest concern to researchers (38%) is the "lack of clarity" of much of the writing, along with lack of consistency in organization and presentation of data.

Changes. Both executives and researchers agree that NASA reports could be briefer or more concise (see Table 47). This might appear to contradict the suggestion that NASA reports also should have more complete data, but a distinction appears to be made by executives and researchers between the basic prose text and the supporting data. There is, of course, substantial overlap between "writing style" and an earlier section in this section entitled "procedural content." Generally, writing style is perhaps one of the least significant general issues identified, although there were suggestions or comments made in this area.

Table 46. Writing Style: Major Inadequacies of NASA Technical Information*

Inadequacy	Executives	Researchers
Too Formal, Tutorial	63%	31%
Repetitious	25	19
Writing Lacks Clarity	13	38
Lack of Consistency of Organization, Presentation of Data	0	31

*Based on 24 responses; 8 from executives and 16 from researchers.

Table 47. Writing Style: Recommended Major Changes in NASA Technical Information*

Change	Executives	Researchers
Make Reports Briefer, More Concise	40%	38%
Organize Material Better; Seek Greater Consistency Within and Between Reports	30	38
Provide Examples	30	13
Less Formality, Tutorial Style	0	13

*Based on 14 responses; 6 from executives and 8 from researchers.

Format and Design

Needs. The manner in which NASA publications are designed and produced, including the use of charts and other illustrative matter, is of some importance to executives and researchers.

Table 48 reports data on needs related to format and design. While a slight distinction was made between hard cover publications and NASA technical reports (the latter perhaps referring to a type of publication), both executives and researchers are generally in agreement (43% and 50%) that they prefer print media to any other, with executives expressing some need for information in journal articles, along with regular NASA publications.

Table 48. Format and Design: Major Technical Information Needs*

Need	Executives	Researchers
Hardcover Publications	43%	50%
NASA Technical Reports	43	50
Journal Articles	14	0

*Based on 9 responses, 2 from executives and 7 from researchers.

The personal interviews explored the issue of print vs. microfiche in more depth. There were a number of reasons for preferring print: (1) much of the "keeping abreast" function related to reading NASA technical information is done during lunch or at home or weekends; microfiche copies inhibit this activity; (2) microfiche readers usually are located in the company library; when constant reference to data in a NASA publication is desirable, microfiche is not practical; and (3) the quality of microfiche reproduction is generally rated as "poor."

Another disadvantage of using microfiche with technical reports is that pages cannot be spread out in order to compare tables and other matter; on microfiche, it is necessary to turn back and forth from frame to frame.

Inadequacies. One of the major inadequacies in format and design, Table 49 indicates, is related to graphs and charts. Researchers (67%) are slightly more concerned about this issue than executives (60%). In the personal interviews, some pointed out that the style of graphs and charts used by NASA, while comparable to those of other government agencies, is far behind the level of sophistication used by most companies today. Some examples of organizations which might be considered models in this area are, in addition to business and industry, the Conference Board, SRI, A.D. Little, Defense Marketing Service, and American National Standards Institute Z-49 formats. A specific criticism of NASA graphs is that they often do not have grids or that the resolution of grids is poor.

[illegible] Format and Design: Major Inadequacies of NASA Technical Infor-[illegible]on*

	Executives	Researchers
[illegible] Small, Difficult to Read; No Grids	60%	67%
Too Large and Bulky	27	4
Printing Quality is Weak: Type Size, Reproduction, etc.	7	14
Microfiche Quality Poor	7	4
Printing Quality of Computer Programs is Weak	0	4

*Based on 42 responses; 15 from executives and 27 from researchers.

Changes. Table 50 lists some of the suggestions for changing or improving matters related to design and format.

Researchers (42%), in particular, emphasize the desirability of improving graphics in general, particularly charts and graphs. Another need (28%) is for card decks or, even better, magnetic tapes, to accompany NASA computer programs, along with user manuals. One executive explained that when decks or tapes are not made available, there is a long time lag between publication of the program and availability of the needed software. Some executives also noted some criticism of the quality of this software, often finding rather basic "bugs."

Table 50. Format and Design: Recommended Major Changes in NASA Technical Information*

Change	Executives	Researchers
Improve Graphics, Particularly Charts (Sophistication, Grids, Legibility, etc.)	27%	42%
Provide Computer User Manuals and/or Card Decks/Magnetic Tapes for Computer Programs	20	28
Increase Number of Publications in Hardbound	20	4
Produce More Journal Articles	13	0
Improve Technical Printing and Design Quality of Publications, Including Type Size, Style, etc.	7	18
Improve Readability of Microfiche	7	4
Produce More Textbooks (State-of-the-Art)	7	0
Less Emphasis of Superficial Design Elements	0	4

*Based on 43 responses; 15 from executives and 28 from researchers.

Dissemination Methods

A number of issues were identified relating to how NASA technical information is distributed through STIF and other services, received by companies, and disseminated within organizations. Tables 51 through 53 summarize these data.

Needs. Half of the comments by executives and roughly a third by researchers were concerned with the timeliness of distribution as a major need related to distribution of NASA publications (see Table 51). The problem expressed by managers in the personal interviews is less the delivery system from STIF to companies than it is perceived to be a problem of NASA "turn-around" time. "It just takes too long," one executive said, "between the tests and the final report." On the other hand, one executive also pointed out that while turn-around time appeared to be excessively long, one of the benefits of NASA publications is that they are carefully, even painstakingly reviewed by NASA committees and, thus, ultimately emerge with the high quality information for which NASA is respected.

Table 51. Dissemination Methods: Major Technical Information Needs*

Need	Executives	Researchers
Timely Distribution	50%	36%
Good Information Retrieval Systems, Index, Key Words, etc.	43	8
Personal Contact with NASA Personnel	7	19
Publication of Works-in-Progress, Working Papers	0	20
Lists of New Titles	0	17

*Based on 28 responses; 14 from executives and 14 from researchers.

It is perhaps because of this problem of timeliness that a second major need, expressed by researchers (20%) but not by executives, is publication of works-in-progress, working papers, and interim reports. The need to get timely information also underlines the importance of having contacts at NASA so that information can be obtained before it is published.

A third type of need covered in this table, expressed particularly by executives (43%), is for better information retrieval systems.

Inadequacies. Table 52 underscores these issues as major inadequacies of NASA technical publications.

Table 52. Dissemination Methods: Major Inadequacies of NASA Technical Information*

Inadequacies	Executives	Researchers
Information Not Received When Timely	66%	62%
Distribution System Too Restricted (Send Directly to Users)	15	6
Information Difficult to Obtain	10	19
Retrieval System (Indexing, Key Words, STAR) are Inadequate	8	13
Adequate Author Information not Included (Who and Where to Contact)	0	1

*Based on 166 responses; 59 from executives and 107 from researchers.

"Frequently," an executive complained, "the information we really need for a project doesn't arrive at the beginning but toward the middle of the project." The reason for this, again, was cited not as a delivery system problem but the slowness by NASA in producing reports.

Change. In Table 53, the same problem of timeliness (46% and 41%, also covered in detail in earlier sections of this report) emerges as the top-ranked recommendation for change in existing procedures. Another recommended change is a better system of indexing information for retrieval (18% of the executives and 21% of the researchers recommended this change). The following were some of the suggestions forwarded in the personal interviews for solving this problem:

(1) The index cards at the back of reports, formerly provided by NASA, were more effective than the DIALOG system which replaced

it. DIALOG, one executive reported, is used mainly by librarians.

(2) A digest, listing all the special categories in NASA/SCAN would be helpful in searching for and sorting out information which is needed. The computer programs available in this area too often produce unneeded data or data which are not relevant.

(3) Collation and summarization of the various widely researched areas, similar to the Air Force's Data Compendium, would prove helpful to many researchers.

Table 53. Dissemination Methods: Recommended Major Changes in NASA Technical Information*

Change	Executives	Researchers
More Timely Publication	46%	41%
Better Indexing, Data Retrieval Systems, Key Words, and Number Systems	18	21
Publish Lists of New Titles	11	11
Issue Works-in-Progress, Working Papers, and Interim Reports	8	4
Improve Mailing Lists	5	2
More Frequent Publication	3	9
Distribute Directly to Users	2	6
Declassify Sooner	2	2
Increase NASA Personal Contact	2	2
Issue Free	1	1

*Based on 163 responses; 61 from executives and 102 from researchers.

Conclusions

In the personal interviews two broad issues were discussed more than any others. These had to do with NASA leadership and NASA performance of basic research. Most executives seemed to feel that, despite the valuable services performed by NASA and the overall high quality and dependability of its information and despite its unquestioned leadership in aerospace, NASA is not providing the kind of leadership needed by the aeronautical industry. Opinions about whether or not NASA should be doing more basic research ranged from "basic research is desirable but not at the expense of the applied research NASA is doing" to "basic research should be NASA's primary orientation."

Some other themes were repeated from company to company. One was the need for better overall integration of all research activities in the field. Related to this was the suggestion, reported both in the questionnaires and personal interviews, that NASA periodically produce publications on the state-of-the-art and that individual reports attempt to better correlate data from existing relevant research projects. One of the major inadequacies of NASA technical publications is insufficient data, needed by researchers in companies to effectively evaluate outcomes. This becomes even more critical because of the tendency of NASA publications not to come to definitive conclusions.

Of all the changes NASA might undertake to make technical information more accessible to executives and researchers, perhaps the most requested is more timely publication. Short of this, a suggestion was made several times that NASA publish more works-in-progress, interim reports, or progress reports. Other publications requested were lists of new titles with better abstracts and summaries, published in some digest form by categories relevant to executives and researchers, as well as directories of NASA personnel and on-going projects and their contacts.

More interaction with NASA personnel is desired almost universally, although that interaction which exists is termed "excellent" to "outstanding." Once contacted, NASA personnel appear to be highly responsive to the needs of company personnel.

The thirst for more and more information on specialized topics is great. However, many executives caution that NASA is perhaps "spreading itself too thin," giving basic topics too "broad a brush," and sometimes bordering on sacrificing quality for quantity. Some of these concerns are echoed in the criticisms of reports with insufficient data, weak correlations, and lack of relating one project to other similar ones.

THE IMAGE OF NASA TECHNICAL INFORMATION

The multidimensional scaling portion of the study was undertaken to provide preliminary information on the image that industry users have of NASA technical information. The data in this section are reported in three ways. First, a matrix of mean distances among all the concepts is presented and discussed. This information can be used to determine the distance among each pair of concepts, including those which are nearest to each other and those which are farthest apart. Second, the reference coordinates for a multidimensional space are provided along with the graphic plot of the location of the concepts in the space. These coordinates and plots are centered on the concept of "NASA Technical Information" so as to determine the relationship between the respondents' assessment of various aspects of technical information, including the concept of "NASA Technical Information," and the concept "My Job." Finally, data are presented which assess the potential of using each of the concepts in the space to construct messages to move the concept of "NASA Technical Information" closer to the concept of "My Job."

For example, a library may be concerned about the effectiveness of its services as perceived by users of the library. Traditional research can identify usage patterns, attitudes, and other information of value to the library. Unanswered, however, may be specific direction on message strategies, or ways to communicate existing services of which users are not aware or changes in current communication strategies to achieve greater acceptance of library policies and procedures. This is one area in which MDS can be of assistance. It does this by showing the relationship of concepts or terms to each other multidimensionally. In interviewing users of library services, concepts which are important to them in relation to the library are identified. The users then are asked to estimate the distance these concepts are from other key concepts. These might be "my work" and "the library." To continue the example, the concepts important to the users might be "convenient hours" and "adequate assistance." If "the library" and "my work" are considered by participants in the study to be some distance from each other, while "convenient hours" and "adequate assistance" are close to "my work" and distant from "the library," use of MDS techniques indicates that to bring the concept of the library closer to the work of the respondent, emphasis should be placed on communicating information about the library's hours and ability to be of personal assistance. For this NASA study, 12 concepts were used and 66 relationships evaluated to identify which concepts, if moved through communication messages and other efforts, would better identify NASA technical information as valuable or useful to company personnel.

The Distance Between Concepts

The distance between a pair of concepts in the multidimensional space indicates the similarity or dissimilarity between that pair of concepts. As indicated in Chapter Two, data are analyzed separately for scientists and technologists. Table 54 presents the mean (arithmetic average) distance between each pair of concepts for the scientists; Table 55 presents the data for the technologists. The closer the value is to 0.0, the more the respondents saw the two concepts as identical. Conversely, the larger the mean value, the less similar the two concepts are considered to be.

The average similarity for all pairs of concepts was 65.8 for the scientists and 75.0 for the technologists. The range of the means was 29.1 to 111.2 for the scientists and from 27.3 to 123.1 for the technologists. Thus, the two groups were reasonably similar in their overall average and range of similarity judgments.

The most important comparisons for the purposes of this study are between the focal concepts, "NASA Technical Information" and "My Job," and the other ten concepts in the space. Column 1 of Table 54 indicates that the two concepts most closely related to "NASA Technical Information" for the scientists were "Respected" (with a mean of 36.8) and "Aerospace" (47.2). The two concepts which were least similar to "NASA Technical Information" were "Timely" (79.8) and "Problem Solving" (81.0). In other words, while scientists viewed NASA Technical Information as respected and related to

Table 54. Mean Distances Among Twelve Pairs of Concepts for a Sample of Aeronautical Scientists*

	1	2	3	4	5	6	7	8	9	10	11	12
1	---											
2	71.96	---										
3	79.80	53.14	---									
4	58.24	50.59	60.50	---								
5	49.21	40.88	46.67	49.80	---							
6	65.26	56.18	74.22	68.82	50.59	---						
7	36.77	47.06	96.96	108.24	60.98	74.80	---					
8	49.02	61.76	86.80	106.47	69.10	86.70	68.20	---				
9	80.98	29.12	70.78	69.02	43.18	55.88	64.31	66.86	---			
10	67.69	40.14	78.24	87.55	47.84	72.35	70.69	69.20	35.49	---		
11	47.26	50.49	90.70	97.35	59.60	84.00	76.20	44.21	54.80	62.84	---	
12	60.10	81.09	111.20	86.47	56.37	98.00	60.00	75.00	62.20	39.12	65.78	---

LEGEND:

1 = NASA Technical Information
2 = My Job
3 = Timely
4 = Accessible
5 = Useful
6 = Adequate
7 = Respected
8 = Aeronautical
9 = Problem Solving
10 = Ideas
11 = Aerospace
12 = Basic Research

Mean distance is 65.8; the range is 29.1 to 111.2

*See multidimensional scaling research instrument. Based upon 50 responses from scientists in five aeronautics companies.

Table 55. Mean Distances Among Twelve Pairs of Concepts for a Sample of Aeronautical Technologists*

	1	2	3	4	5	6	7	8	9	10	11	12
1	---											
2	81.20	---										
3	87.65	40.22	---									
4	64.80	55.94	66.20	---								
5	59.18	31.35	45.10	52.02	---							
6	75.00	37.42	75.10	77.08	68.80	---						
7	41.44	36.94	101.20	99.50	77.10	88.10	---					
8	57.00	59.40	96.90	97.86	74.90	94.29	95.10	---				
9	82.96	27.32	76.20	75.20	57.90	66.10	74.90	69.30	---			
10	71.42	43.22	83.10	97.30	67.80	104.30	93.80	73.90	40.70	---		
11	45.20	71.20	92.60	116.02	97.90	110.82	93.80	59.10	70.30	71.44	---	
12	62.40	111.50	103.30	103.88	90.60	123.18	102.18	74.20	84.72	43.10	81.40	---

LEGEND:

1 = NASA Technical Information
2 = My Job
3 = Timely
4 = Accessible
5 = Useful
6 = Adequate
7 = Respected
8 = Aeronautical
9 = Problem Solving
10 = Ideas
11 = Aerospace
12 = Basic Research

Mean distance of .75.02; the range is 27.3 to 123.1

*See multidimensional scaling research instrument. Based upon 50 responses from technologists in five aeronautics companies.

aerospace, they considered it neither very timely nor relevant to aeronautics, in the context of the 12 concepts which they were asked to compare. The data in Column 1 of Table 55 indicates that for technologists the two concepts that were closest to their view of "NASA Technical Information" are "Respected" and "Aerospace" with means of 41.4 and 45.2, respectively. The two concepts least similar were "Timely" (87.6) and "Problem Solving" (82.9). In other words, like the scientists, the technologists viewed NASA Technical Information as respected and related to aerospace; however, NASA Technical Infor-ation was not perceived as very timely nor a major help in solving problems.

When the scientists expressed their views toward their work, the concept of "My Job" (see Column 2), the three concepts which were reported as closest to their conception of their job were "Problem Solving" (29.1), "Ideas" (40.1), and "Useful" (40.9). The three concepts least associated with "My Job" were "Aeronautics" (61.8), "NASA Technical Information" (72.0), and "Basic Research" (81.1). Among the technologists, the three concepts most similar to "My Job" (see Column 2) were "Problem Solving" (27.3), "Useful" (31.4), and "Respected" (36.9). The concepts that were least similar were "Aerospace" (71.2), "NASA Technical Information" (81.2), and "Basic Research" (111.5). For both groups, the concepts of "Problem Solving" and "Useful" are central to their view of their work. "Ideas" are important to scientists, while "Respected" is important to technologists. Both groups are also in agreement that "Basic Research" and "NASA Technical Information" are <u>least</u> similar to their job conception. In addition, scientists include "Aeronautics" and technologists include "Aerospace" in this group of least similar concepts.

The Relationship of NASA Technical Information to "My Job"

Using a multidimensional scaling routine, data for the 12 concepts were analyzed to provide coordinates and plots for a three dimensional space. Figure 1 provides plots for scientists and Figure 2 for technologists. Reference coordinates for the 12 concepts of three-dimensional space are in Table 56 for both groups. To center the "NASA Technical Information" concept, the coordinate system is standardized and centered at the 0.0 point for each coordinate (i.e., the origin). The concepts are located in space in relation to their projection on the three reference coordinates. For example, the concept of "My Job" projects onto the first coordinate dimension at 72.1 units from 0.0 for scientists and -2.74 units for technologists. Table 56 also shows that the three dimensions of the coordinate system account for 82% of the variance in the data for scientists and 80% for technologists. Both ...es are quite high for human respondent data, supporting the validity of ...mensional scaling analysis.

Si... coordinate system is centered on the concept of NASA Technical Information, the column in Table 56 labeled "Vector Distance" represents the distance between these two concepts. Examination of this column shows that the concepts farthest from NASA Technical Information for scientists are "Problem Solving" (83.80), "Timely" (75.09), and "My Job" (73.04); for technologists, these concepts are "My Job" (90.90), "Problem Solving" (81.76), and "Timely" (79.21). Concepts closest to NASA Technical Information for scientists are "Respected" (29.89) and "Aerospace" (39.83) while for technologists the closest concents are "Aeronautical" (39.94) and "Respected" (43.87). The distance of the concept of "My Job" from the concept of NASA

Table 1.

The Image of NASA Technical Information Held by

Aeronautical Industry Scientists

THE IMAGE OF NASA TECHNICAL INFORMATION HELD BY

AERONAUTICAL INDUSTRY SCIENTISTS

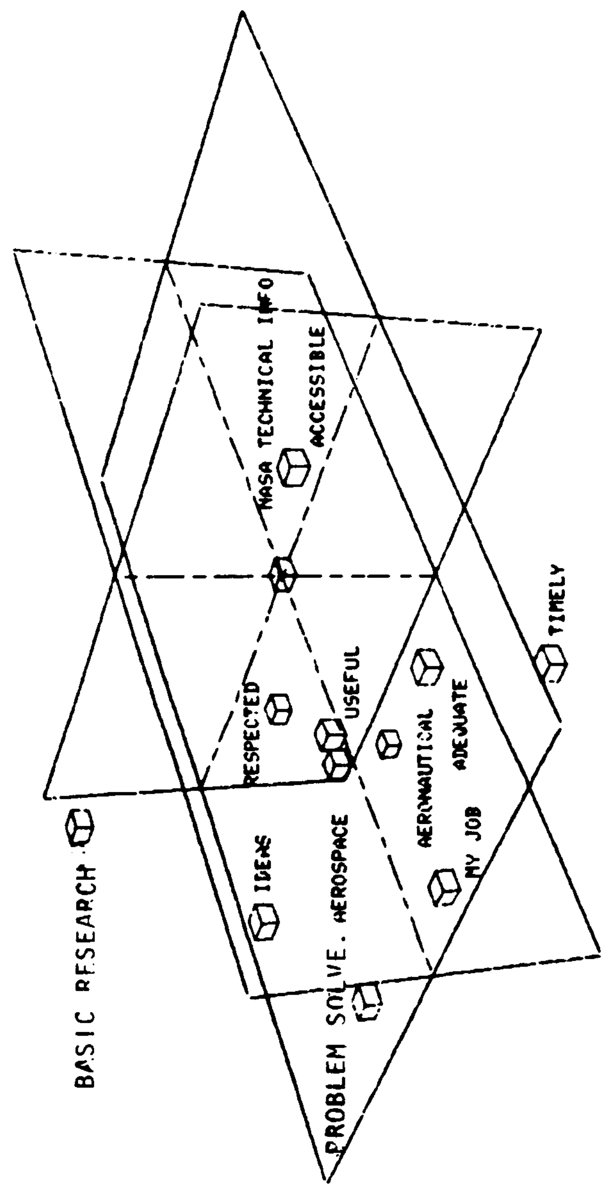

Table 2.

The Image of NASA Technical Information Held by

Aeronautical Industry Technologists

THE IMAGE OF NASA TECHNICAL INFORMATION HELD BY

AERONAUTICAL INDUSTRY TECHNOLOGISTS

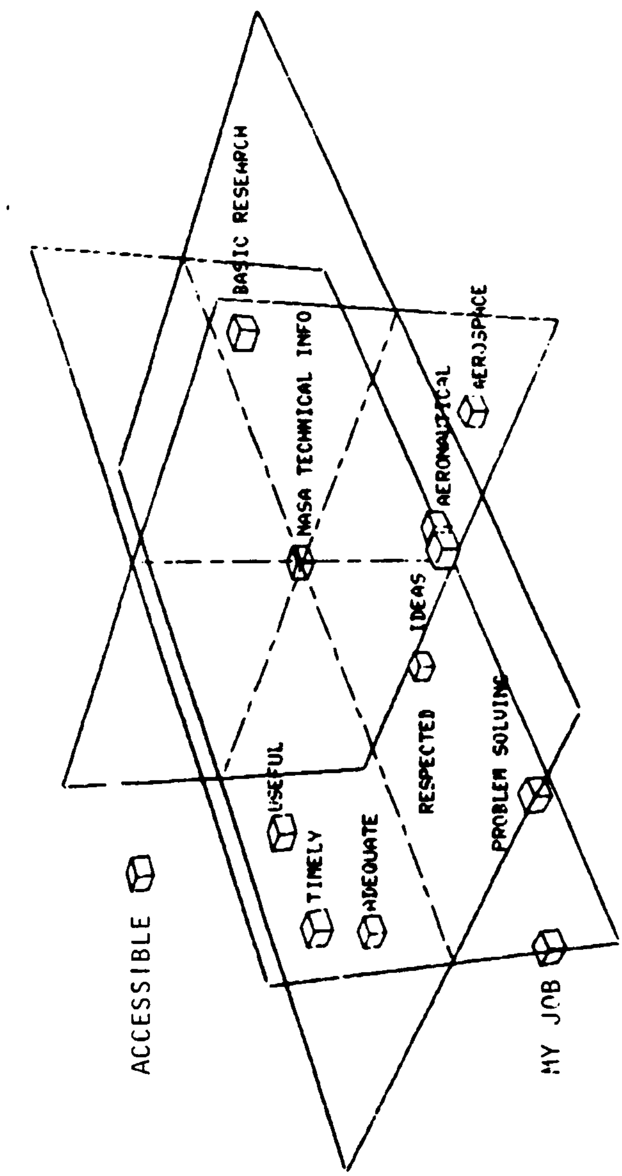

Table 56. Reference Coordinates for Three Dimensions of the Multidimensional Space for Scientists and Technologists*

	Scientists				Technologists			
	Dimensions			Vector	Dimensions			Vector
Concepts	1	2	3	Distance	1	2	3	Distance
NASA TECHNICAL INFORMATION	00.00**	00.00	00.00	0	00.00	00.00	00.00	0
MY JOB	72.13	- 1.73	-11.36	73.04	87.19	- 2.74	-25.56	90.90
TIMELY	59.78	39.93	-22.50	75.09	75.85	- 6.65	21.84	79.21
ACCESSIBLE	29.91	53.33	28.34	67.39	40.34	-35.62	39.70	66.87
USEFUL	45.48	8.04	8.63	46.98	51.83	-12.56	18.75	56.53
ADEQUATE	43.67	22.21	- 8.95	49.80	53.02	-41.82	-13.66	68.90
RESPECTED	7.17	-28.25	- 6.64	29.89	6.34	-21.58	-37.67	43.87
AERONAUTICAL	15.54	-30.64	-33.76	48.17	22.44	30.71	-12.20	39.94
PROBLEM SOLVING	81.87	-17.32	4.37	83.80	76.77	24.31	-14.14	81.76
IDEAS	57.16	-26.84	15.29	64.97	48.66	51.38	6.24	71.04
AEROSPACE	21.64	-28.92	-16.78	39.83	1.21	39.27	-27.21	47.79
BASIC RESEARCH	23.52	-39.78	43.35	63.36	1.52	54.46	33.17	63.78
Cumulative Percent of Variance Accounted for	50.42%	71.00%	81.50%		548.52%	69.02%	80.43%	

*See multidimensional scaling research instrument. Results are based upon responses from 50 scientists and 50 technologists in five aeronautical companies.
**The coordinate system is centered on NASA Technical Information; hence, the coordinates for this concept are zero.

Technical Information clearly indicates that NASA Technical Information is not seen by these respondents as a vital part of their everyday work process. Neither do they see NASA Technical Information as very timely or as involving problem solving to a very great extent. On the other hand, NASA appears to be highly respected for both groups. Interestingly, scientists associate NASA Technical Information with "Aerospace" while technologists associate it with "Aeronautics," a finding which may reveal an interesting difference between the two groups. These findings are also highly consistent with those obtained for the distance among concept pairs in the previous section.

The Potential for Changing the Image of NASA Technical Publications

As indicated in the preceding section, concepts that are arrayed in a multidimensional space provide a graphic representation of the relationship among those concepts at a particular point in time. But concepts change over time as people learn, gain new experience, receive new information, etc. And often, since the concepts are all related to each other, a change in one concept produces changes in several or all of the others. This fact can be utilized to change the position of any of the concepts in the space because research has shown that it is possible to change the position of one concept relative to another (the two focal concepts) by introducing information about one or more of the remaining concepts in the space. Those concepts which by virtue of their position in the space contain the greatest potential for changing the distance between the focal concepts can be used to develop message strategies designed to impact on them. The difficult part is to determine those concepts about which new information should be introduced.

The procedure works as follows. The goal is to move one concept closer to the other in the space, since as research in the areas of voting behavior, adoption of innovations, and marketing has shown, when the distance between two concepts shrinks, the concepts are seen as being more similar. Technically, this means calculating the resultant of the vector space defined by each possible subset of concepts; that resultant which lies closest to the vector between the two focal concepts identifies that set of concepts which should provide the greatest potential for moving the selected concept toward the target concept.

The focus of the present study makes it appropriate to explore the potential for moving the concept of "NASA Technical Information" closer to the concept of "My Job." In order to determine which of the other ten concepts in the space should be used as the foundation for message strategies, all possible combinations of concepts should, ideally, be examined: one concept, two concept, three concept strategies and so on through the single ten concept strategy. Changes in those concepts which move the concept of "NASA Technical Information" closest to the concept of "My Job" can then be selected as the basis for message strategies.

In Table 57 we provide the top three message strategies for moving the concept of "NASA Technical Information" toward the concept of "My Job." Four sets of strategies are presented: the best three using a single concept, plus the best three strategies using two concepts, three concepts, and four concepts. Strategies are presented separately for the scientists and technologists.

Table 57. Three Best Message Strategies for One, Two, Three, and Four Concept Sets to Move the Concept of "NASA Technical Information" Closer to "My Job" for Scientists and Technologists

Rank Order	Concepts (Correlation)	
	Scientists	Technologists
One Concept Set		
1	Problem Solving (.93)	Useful (.95)
2	Useful (.84)	Problem Solving (.95)
3	Ideas (.84)	Timely (.89)
Two Concept Sets		
1	Timely/Aerospace (.99)	Timely/Adequate (.99)
2	Useful/Aerospace (.99)	Accessible/Problem Solving (.98)
3	Adequate/Respected (.98)	Accessible/Adequate (.97)
Three Concept Sets		
1	Useful/Adequate/Aeronautics (.99)	Aeronautics/Problem Solving/Ideas (.97)
2	Timely/Problem Solving/Aerospace (.99)	Timely/Accessible/Useful (.94)
3	Timely/Accessible/Ideas (.99)	Timely/Adequate/Basic Research (.93)
Four Concept Sets		
1	Timely/Problem Solving/Ideas/ Aerospace (1.00)	Accessible/Useful/Aeronautics/Basic Research (.99)
2	Timely/Accessible/Problem Solving/ Aerospace (.99)	Timely/Accessible/Adequate/Basic Research (.99)
3	Accessible/Useful/Adequate/Ideas (.99)	Timely/Useful/Adequate/Basic Research (.99)

The number in parentheses after each concept set is a correlation coefficient representing the degree of association or closeness between the vector for the focal pair (i.e., the selected concept and the target concept) and the resultant vector for the concept set listed. The closer this number is to 1.0, the closer that these two vectors lie to each other and the greater the potential of the concept set to move the selected concept toward the target concept.

Table 57 shows that single concept messages that emphasize "Problem Solving" will be most effective with scientists, while messages that concentrate on showing that "NASA Technical Information" is "Useful" or will involve "Problem Solving" will have the greatest impact on technologists. If a single concept message that will work reasonably well with both groups is desired, the concept of "Problem Solving" is the best choice. In this approach, NASA technical documents would be reviewed carefully to determine their ability to assist users in solving problems and a concerted attempt would be made to develop messages to convey this feature.

If two concepts are emphasized within the same message, the best choice for scientists is "Timely" and "Aerospace," while for technologists it is "Timely" and "Adequate." Note that for scientists, the concept of "Aerospace" appears in two of the top three message choices, while among technologists the concepts of "Accessible" and "Adequate" each appear twice.

When three concepts are embodied at the same time in a message, the best choice for scientists is "Useful," "Adequate," and "Aeronautics." For technologists, the equivalent choice is "Aeronautics, "Problem Solving," and "Ideas." "Timely" is the only concept to appear more than once among the top three sets for scientists or for technologists.

Finally, under the four concept message possiblities, the single best choice for scientists is a strategy that embodies the concepts of "Timely," "Problem Solving," "Ideas," and "Aerospace." Technoloigsts can be communicated to most effectively using the concepts of "Accessibility," Useful," "Aeronautics," and "Basic Research." Inspection of the concept sets listed under the four concept heading indicates that there are several concepts that appear twice, but none more than that often.

Given these initial results outlining the concept sets best suited for a message strategy to unite the concepts of "NASA Technical Information" and "My Job," the problem becomes one of selecting the "best" strategy to employ. Two factors should influence this decision. The first is a statistical criterion: which strategy provides the greatest likelihood of creating the desired movement between "NASA Technical Information" and "My Job?" The second factor is a pragmatic one: which strategy is best suited to actual implementation; in other words, which strategy can be most readily turned into a set of operational guidelines such that the messages which are produced as part of NASA's Technical Information activities can be said to embody these attributes?

On the basis of the first criterion, the statistical one, the best strategies for scientists incorporates "Timely," "Problem Solving," "Ideas," and "Aerospace." This suggests that NASA should ensure that its information dissemination is seen as timely (it reaches users sooner than at present), problem solving (deals with major problems of current interest to users), ideas (presents and initially tests out new ideas), and aerospace (deals with aerospace topics). For technologists, the best strategy on a statistical basis is to emphasize "Accessibility," "Useful," "Aeronautics," and "Basic

Research." That is, the messages would reflect a greater involvement of aeronautical researchers in NASA equipment and facilities (such as the wind tunnels), that the research be useful (relevant to the incremental research favored by aeronautical workers), pertaining to aeronautics problems (rather than aerospace), and reflecting basic research (rather than more "ivory tower" research).

However, it might not be feasible to engage in a strategy that required technical information that is adapted to specific audiences. Furthermore, following the second criterion noted above, it might not be feasible to implement some aspects of a particular strategy, for pragmatic or policy reasons, etc. In that event, an alternative strategy, one that seemed to be appropriate to both types of respondents, is indicated. This means selecting a strategy that will be effective with both groups at the same time, even though other strategies are available on an individual basis. Using this second criterion, an optimal strategy can be suggested: "Timely," "Adequate," and "Basic Research." This strategy is among the top three concept strategies for technologists and, while there are some better scientist strategies, it is nearly as strong (it was fourth best). This strategy suggests that NASA Technical Information be planned, conceived, disseminated, and promoted to the aeronautical industry in light of a timeliness goal (is it getting to respondents as soon as they would desire), an adequacy goal (are users getting enough explanation when they receive information, or are there many unanswered questions) and a basic research goal (does the content of the report cover topics that are of fundamental importance to the clients).